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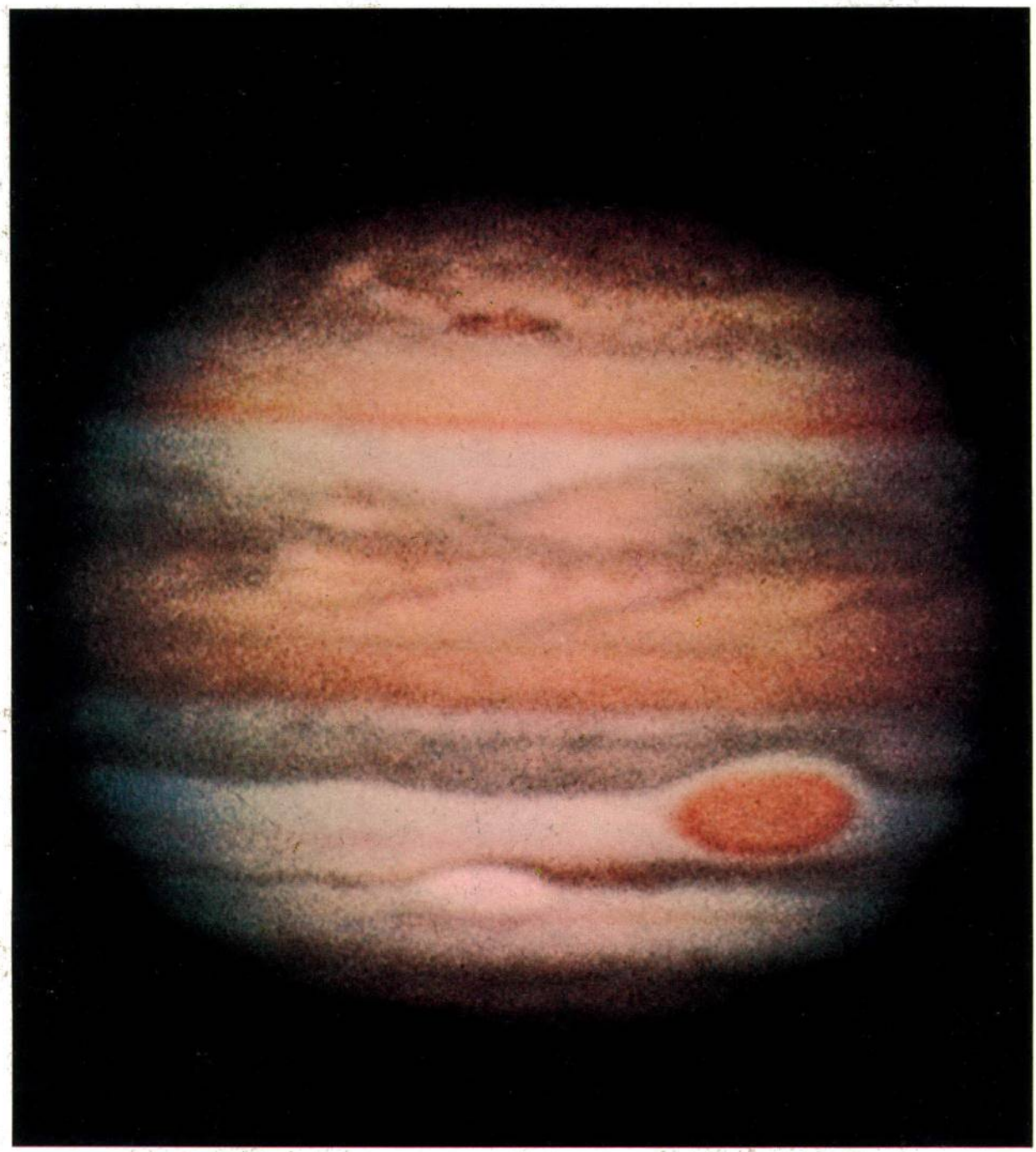

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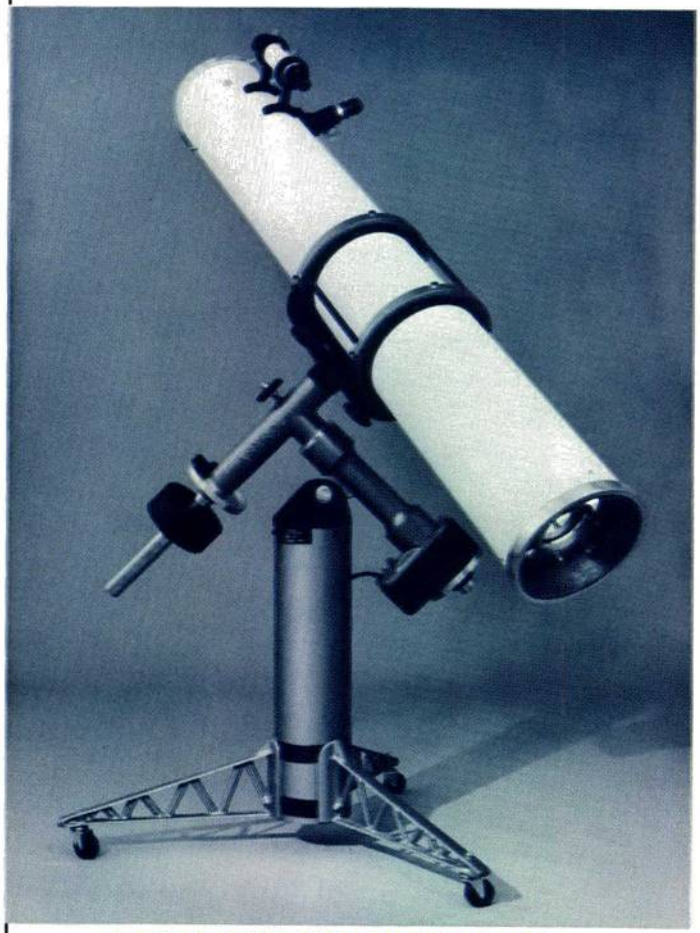

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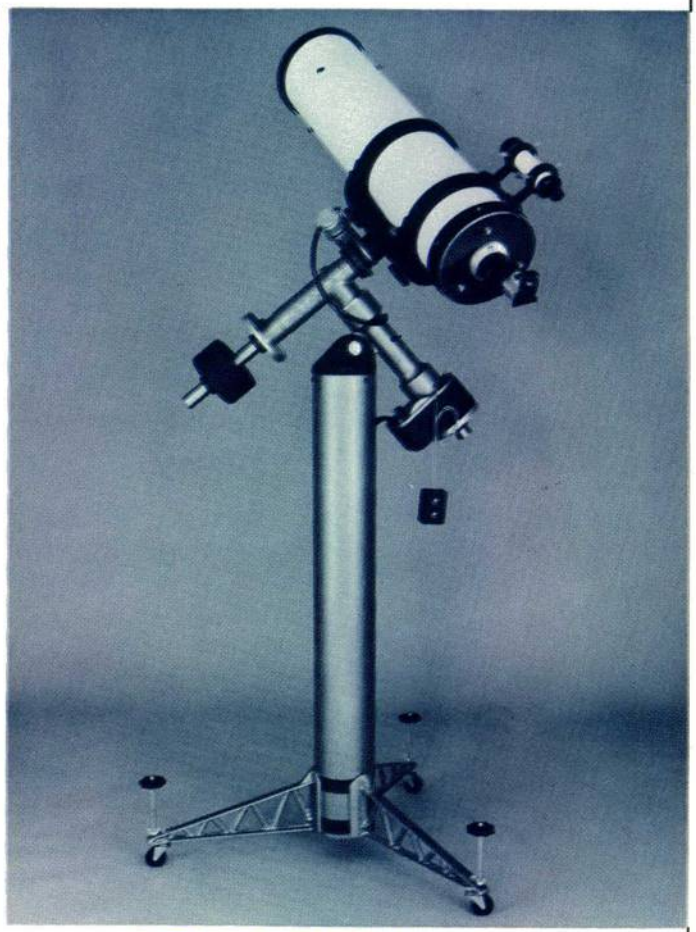

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February 1974 Vol. 2, No. 2

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Kitt Peak Observatory Photograph

Cover: The mysteries of the giant planet Jupiter were explored by the first spacecraft to reach that planet as told in "Encounter With Jupiter", page 4. Photograph by Roger Lynds using Kitt Peak Observatory's 84 inch telescope in 1968.

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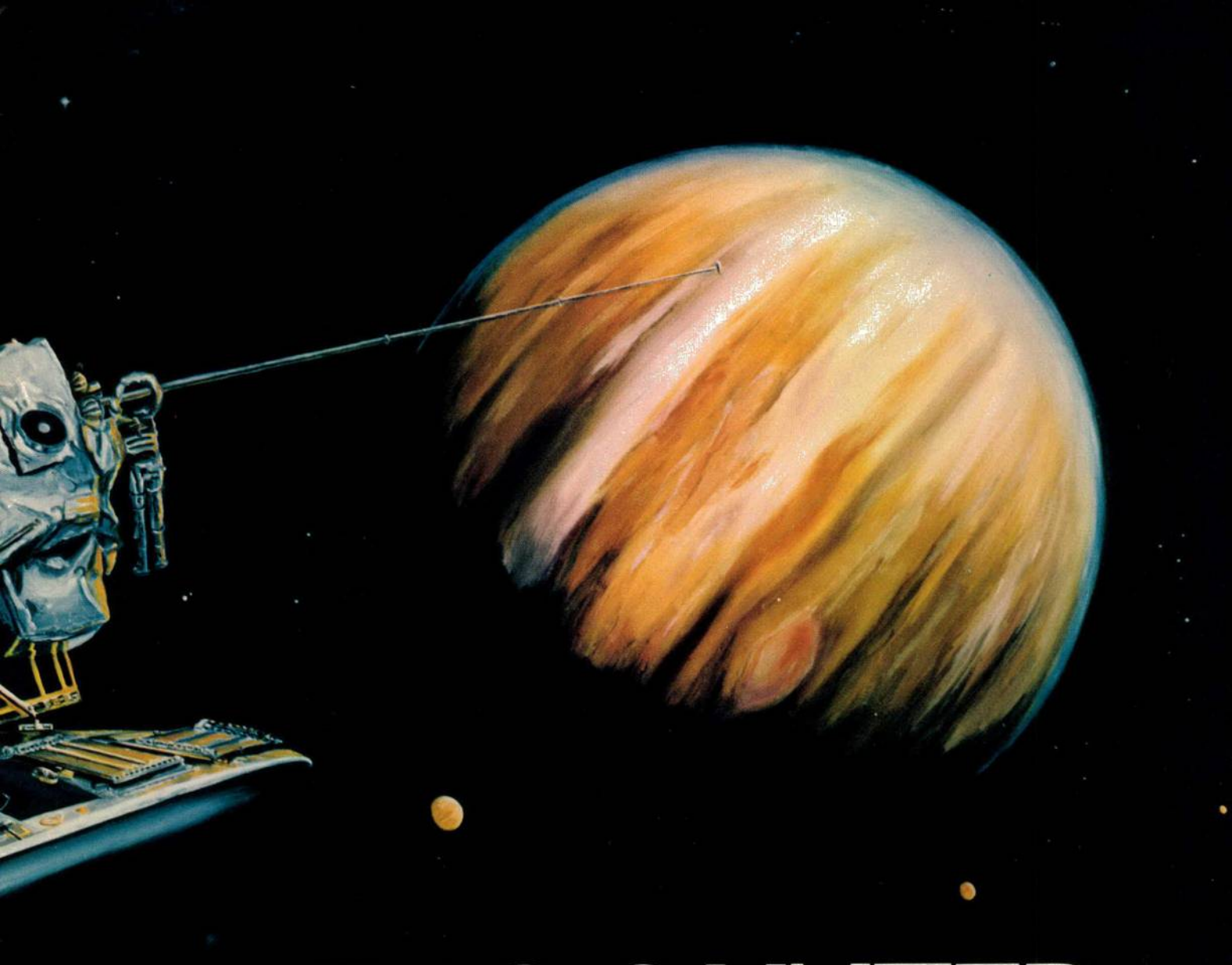


ENCOUNTER WITH JUPITER

Four hundred million miles from Earth is a hulking planet striped by a blanket of wind-swept clouds that churn above a virtual bottomless sea of atmosphere. This is Jupiter — totally alien to our experience, a world that defies understanding. With its enigmatic Great Red Spot and encircling deadly radiation zones, this colossal planet — over 1,000 times larger than Earth — was visited, ever so briefly, by the eyes and mind of man.

Pioneer 10 hurtled past Jupiter on Dec. 3, 1973. The encounter marked man's first attempt to probe the giant planet by spacecraft.

Artwork by John W. Clark

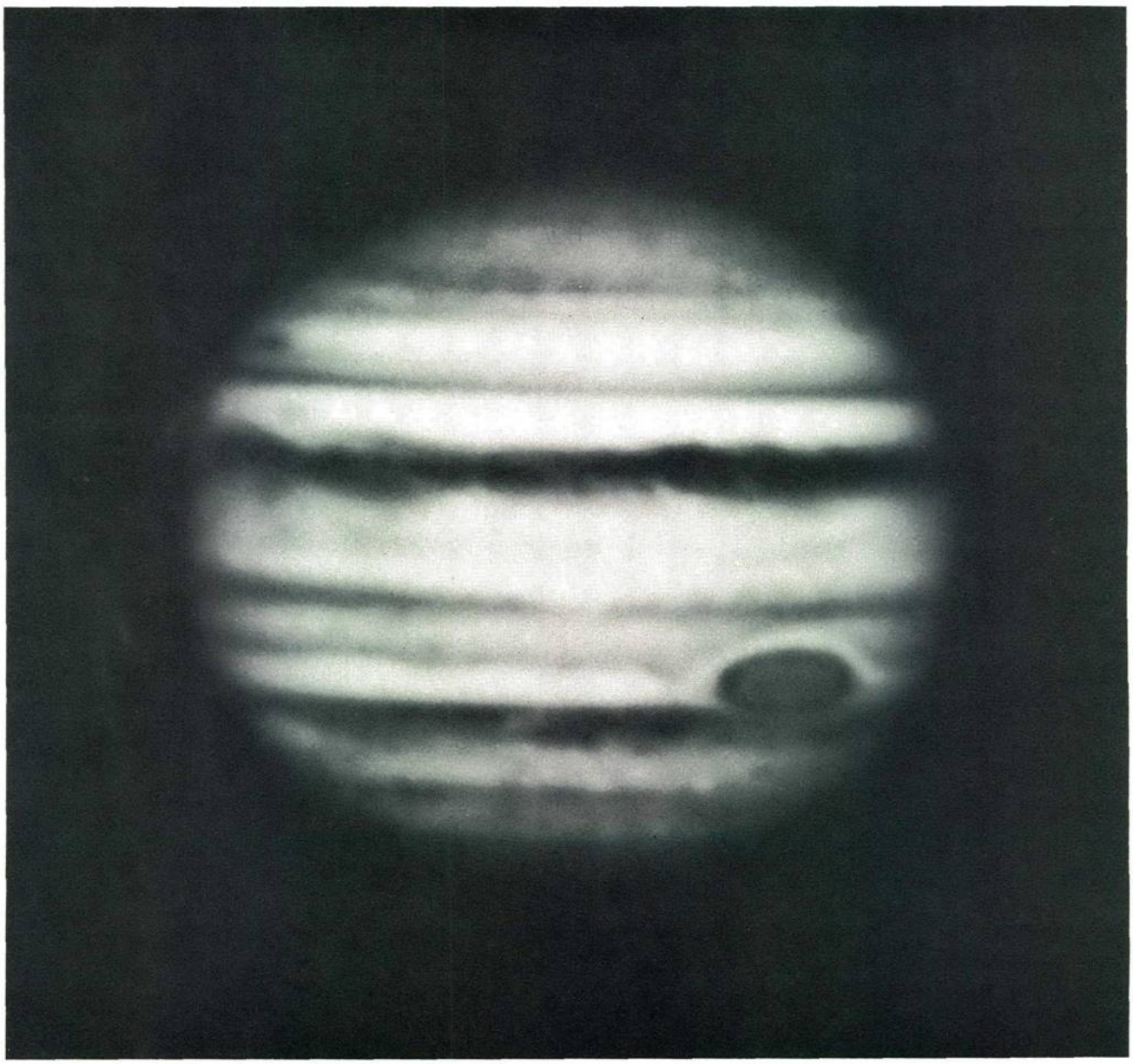
In the form of a small 570 pound spacecraft called Pioneer 10, the inquisitive nature of man was embodied. For nearly two years the interplanetary robot sailed a dark pathway never before explored. Once beyond Mars, Pioneer was in new territory. As it pushed farther down an interplanetary boulevard to its main objective, it proved false the notion that destructive debris litters the asteriod belt between Mars and Jupiter.

On Dec. 3, 1973, Pioneer passed within 81,000 miles of the solar system's largest planet. Jupiter's magnetosphere — a radiation zone of previously uncertain intensity — almost crippled the spacecraft as it withstood a radiation dose 1,000 times the amount usually fatal to man.

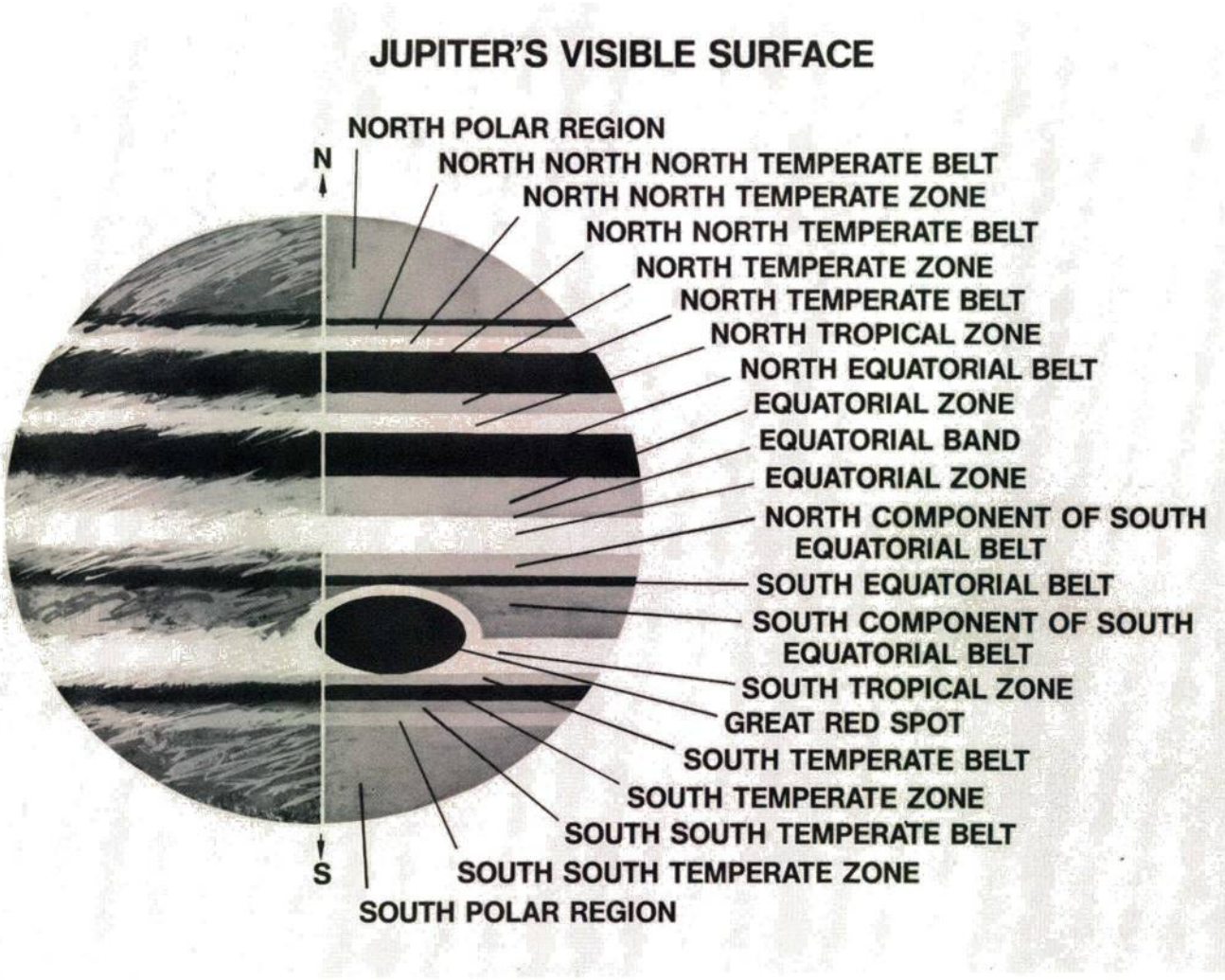
What did Pioneer learn? The mission was a great success. But its origins go back to the first glimpse of Jupiter in a telescope. That opening of the curtain was by Galileo as he peered through his crude "optik tube" in 1609. Reflecting on that event Dr. Charles Hall, Pioneer project manager, said he was "struck by the realization we are only 12 generations away from Galileo and his crude first look at Jupiter. Now we are actually measuring many of the planet's characteristics."

Even with the success of Pioneer 10 many mysteries concerning this super planet remain to be solved. Hundreds of years of astronomical observations and analysis have provided a stock of information to which Pioneer's results have been added.

Seen from Earth, Jupiter is the fourth brightest object in the sky, after the sun, moon and



NASA Photograph



NASA Diagram

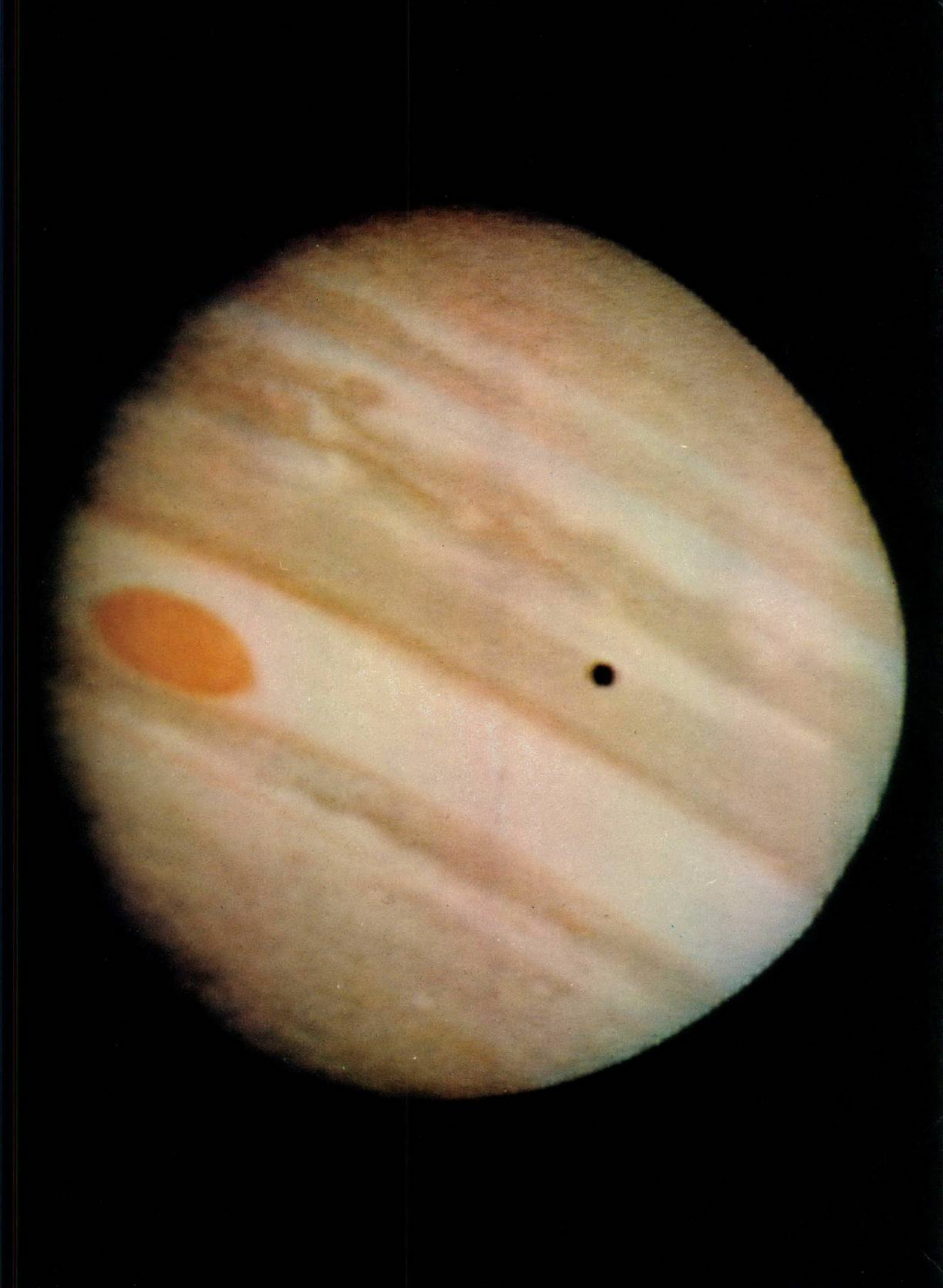
Venus. At five times Earth's distance — 480 million miles — the great world ponderously navigates a huge 12 year orbit about our sun. During its circuits it drags along a dozen moons, two of which are larger than the planet Mercury.

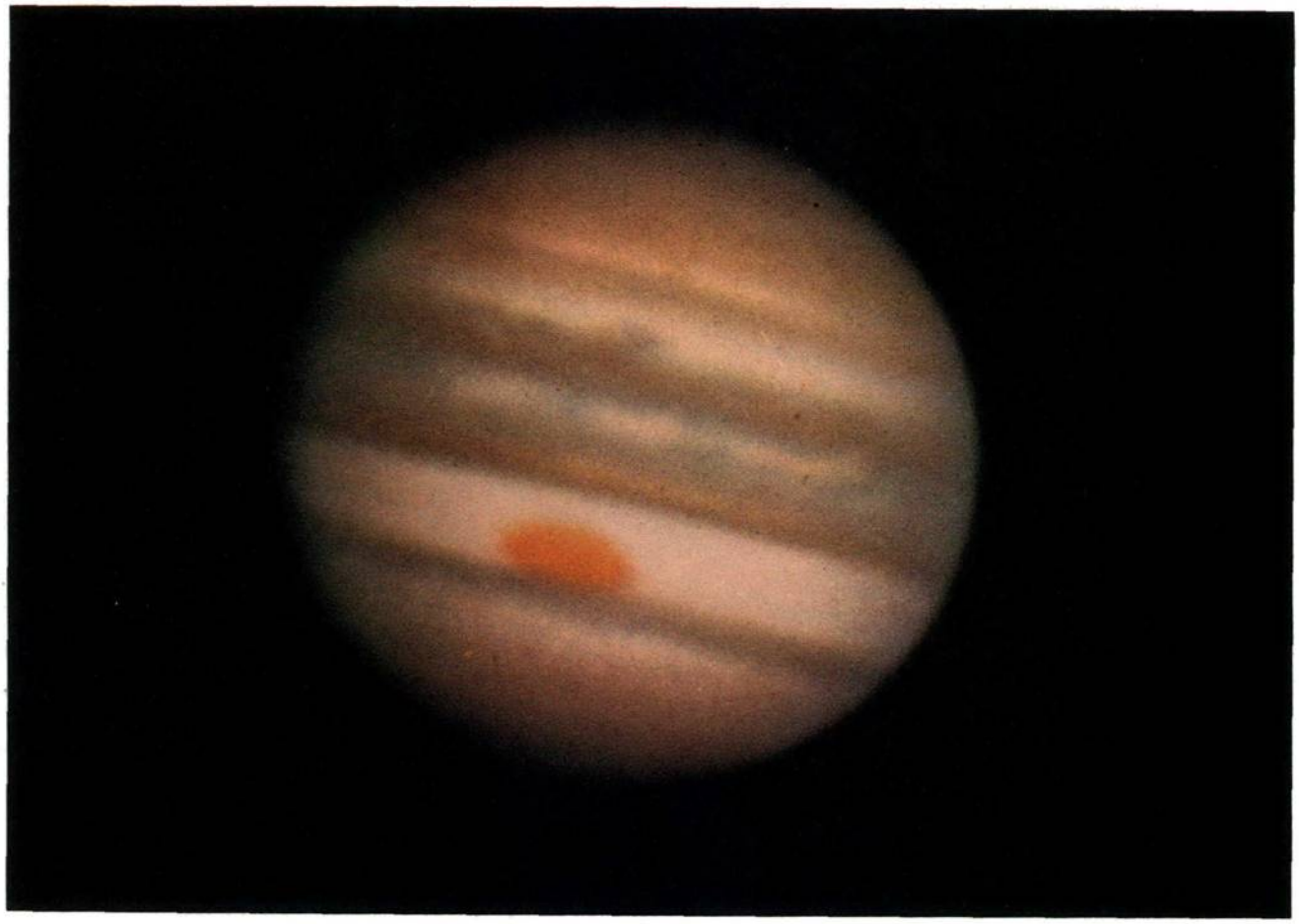
Jupiter completes a rotation once every 10 hours, the shortest day of any of the nine planets. Because of its size, a point at Jupiter's equator (cloud tops) races along at 22,000 m.p.h., compared to a speed of 1,000 m.p.h. for a similar point on Earth. This tremendous rotational speed (and fluid character of the planet) makes Jupiter bulge at its equator resulting in a polar diameter of 77,000 miles, 11,700 miles smaller than its equatorial diameter of 88,700 miles.

The atmosphere of Jupiter is dense, deep and topped by clouds swept into horizontal bands by the planet's 10 hour rotation. The Great Red Spot (lower right) is always at the same latitude but mysteriously drifts in a slow, random east-west fashion. The spot is 25,000 miles wide — three times the diameter of Earth. All the basic visible features of Jupiter have been included in the complex nomenclature shown on this page.

Jupiter's visible surface is 24 billion square miles in area. It's all clouds, but so vast that if Earth were peeled like an orange the skin would not quite cover the Great Red Spot. The mass of the planet is 318 times the mass of Earth, but the stuff it is made of has extremely low density — 1/4 of the earth's or 1.3 times the density of water. Most scientists are sure the planet is made up of a mixture of elements similar to that in the sun or the primordial gas cloud which formed the sun and planets. This means very large proportions of the planet — at least three-quarters — are the light gases hydrogen and helium. Scientists have identified hydrogen, deuterium (the heavy isotope of hydrogen), methane (carbon and hydrogen), and ammonia (nitrogen and hydrogen) by spectroscopic studies of Jupiter's clouds.

When Jupiter passed in front of stars in 1953 and again in 1971, astronomers were able to calculate roughly the molecular weight of its upper atmosphere by the way it refracted the stars' light. They found a molecular weight of around 3.3 indicating a large proportion of hydrogen





Lunar and Planetary Laboratory Photograph

The Great Red Spot and the other distinctive cloud features of Jupiter are well seen in this photo obtained with a 61 inch telescope 19 days before the Pioneer image on the opposite page. The resolution of the two photos is similar — almost identical belts and zones can be identified on each.

(molecular weight 2) because all other elements are far heavier. (Helium is 4; carbon, 12, and nitrogen, 14.)

Through a telescope, the lighted hemisphere of Jupiter — the only one seen from Earth — is almost certainly a view of the tops of a gigantic quilt of towering multicolored clouds. Rapid rotation of the planet has whipped the clouds into distinct bands parallel to its equator. Large dusky gray regions characterize both poles. Usually between the two polar regions are five permanent, bright, salmon colored stripes known as zones, and four darker, slate-gray stripes known as belts — the South Equatorial belt, for example.

Jupiter's Red Spot, and a shadow of the moon, Io, plus the giant planet's cloud structure are shown in this photograph taken Dec. 1, 1973, when Pioneer 10 was about 1,580,000 miles from the planet.

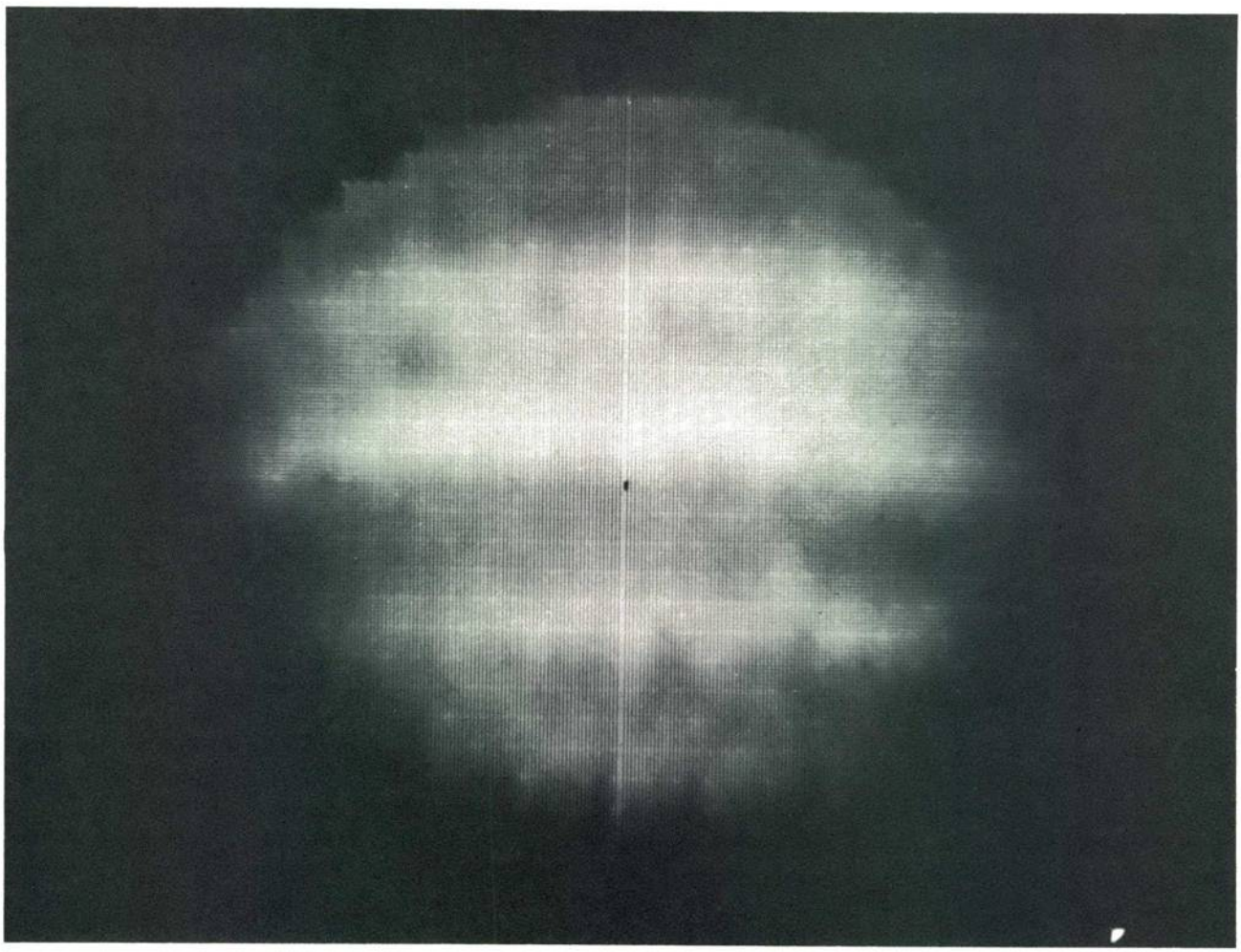
The viewing angle of the spacecraft puts 30 percent of Jupiter in shadow. This color photo is the result of computer processing and rectification of images from Pioneer 10.

NASA Photograph

The planet as a whole changes hue periodically, possibly as a result of the sun's 11 year activity cycles.

Certainly the most puzzling feature of this bizarre world is the Great Red Spot in the southern hemisphere. It is frequently bright red, and since 1665 has disappeared completely several times. It curiously seems to brighten and darken at 30 year intervals. No suitable explanation for the spot has ever been offered because subsequent proof has been lacking. But one of the Pioneer photos shows the spot casting its shadow on the clouds below. Dr. Carl Sagan of Cornell University suggested a few years ago that the spot might be a long lived storm system of organic molecules belched up from lower cloud levels. Atmospheric dynamics suggest such a storm a few miles above the main cloud deck could survive for centuries. Certainly the Pioneer findings will rule out some theories.

Scientists agree that cloud tops in the zones are probably largely ammonia vapor and crystals,



NASA Photograph

This photographic "heat map" of Jupiter was taken by Pioneer 10's infrared instrument on Dec. 3, 1973.

The lightest (warmest) areas are 15 degrees warmer than the darkest (coldest) regions. The measurements confirm that Jupiter produces its own heat — radiating 2-1/2 times as much as it absorbs from the sun. This picture (taken at 40 microns wavelength) measured heat about 20 miles above Jupiter's cloud tops and 30 miles below the top of transparent atmosphere which lies above the clouds. Heat at this level represents the effects of heat coming up from deep within the planet. The picture clearly shows the differences between Jupiter's dark belts and bright zones. The dark red-brown belts on the planet are warmest; the light colored zones, the coldest. Guido Munch, Pioneer infrared experimenter, believes the bright zones are higher cloud bands which overlap the reddish brown cloud layer. Without these bright bands the whole planet might be reddish brown.

and the gray polar regions may be condensed methane. The bright cloud zones have a complete range of colors from yellow and delicate gold to red and bronze. Clouds in the belts range from gray to blue-gray. In addition to the belts and zones, many smaller features — streaks, wisps, arches, loops, patches, lumps, and spots — can be seen. Most are millions of square miles in size. The Great Equatorial current (the Equatorial zone), 20 degrees wide, sweeps around the planet at 255 m.p.h. faster than the cloud regions on either side of it, like similar atmospheric jet streams on Earth. The South Tropical circulating current, also a well-known feature, is a cloud current which sweeps completely around the Great Red Spot.

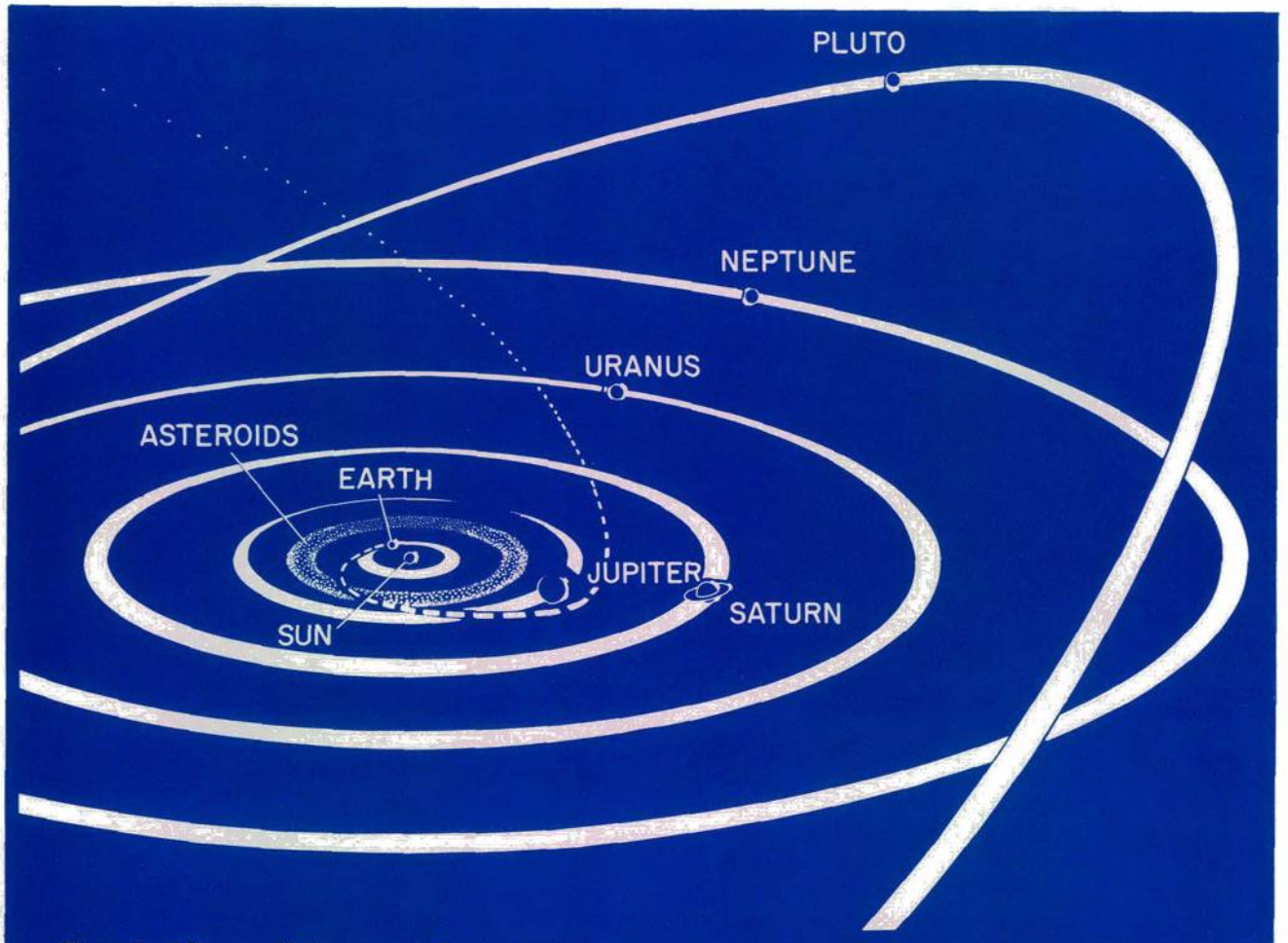
Scientists have suggested from cloud top observations by telescope and from the Pioneer photographs that the general circulation pattern of Jupiter's atmosphere is like that of Earth, with circulation zones corresponding to Earth's equatorial, tropical, subtropical, temperate, subpolar and polar regions. However, Jupiter's polar regions (from an atmospheric circulation standpoint) appear to begin at about 26 degrees latitude from the equator, instead of at 60 degrees as on Earth.

Under Jovian gravity, atmospheric pressure at the cloud tops is calculated to be up to 10 times that on Earth. The transparent atmosphere above the clouds can be observed spectroscopically and in polarized light, and is believed to be at least 30 miles thick. The average temperature at the tops of Jupiter's clouds was accurately

measured by Pioneer 10 to be 208 degrees below zero. When the spacecraft passed behind the great globe it recorded exactly the same temperature on the nighttime side. The dense atmosphere holds heat well and the five hour night is far too short for any cooling to occur. But prior to Pioneer 10 this was only theory. Additional readings from Pioneer's infrared radiometer confirm the hypothesis that Jupiter radiates 2-1/2 times as much energy as it receives from the sun. (See page 55 in the December issue of ASTRONOMY). Another intriguing observation that may yet be answered by further sifting of Pioneer data is that the shadows of Jupiter's moons, when cast on the planet, appear to measure hotter than surrounding sunlit regions.

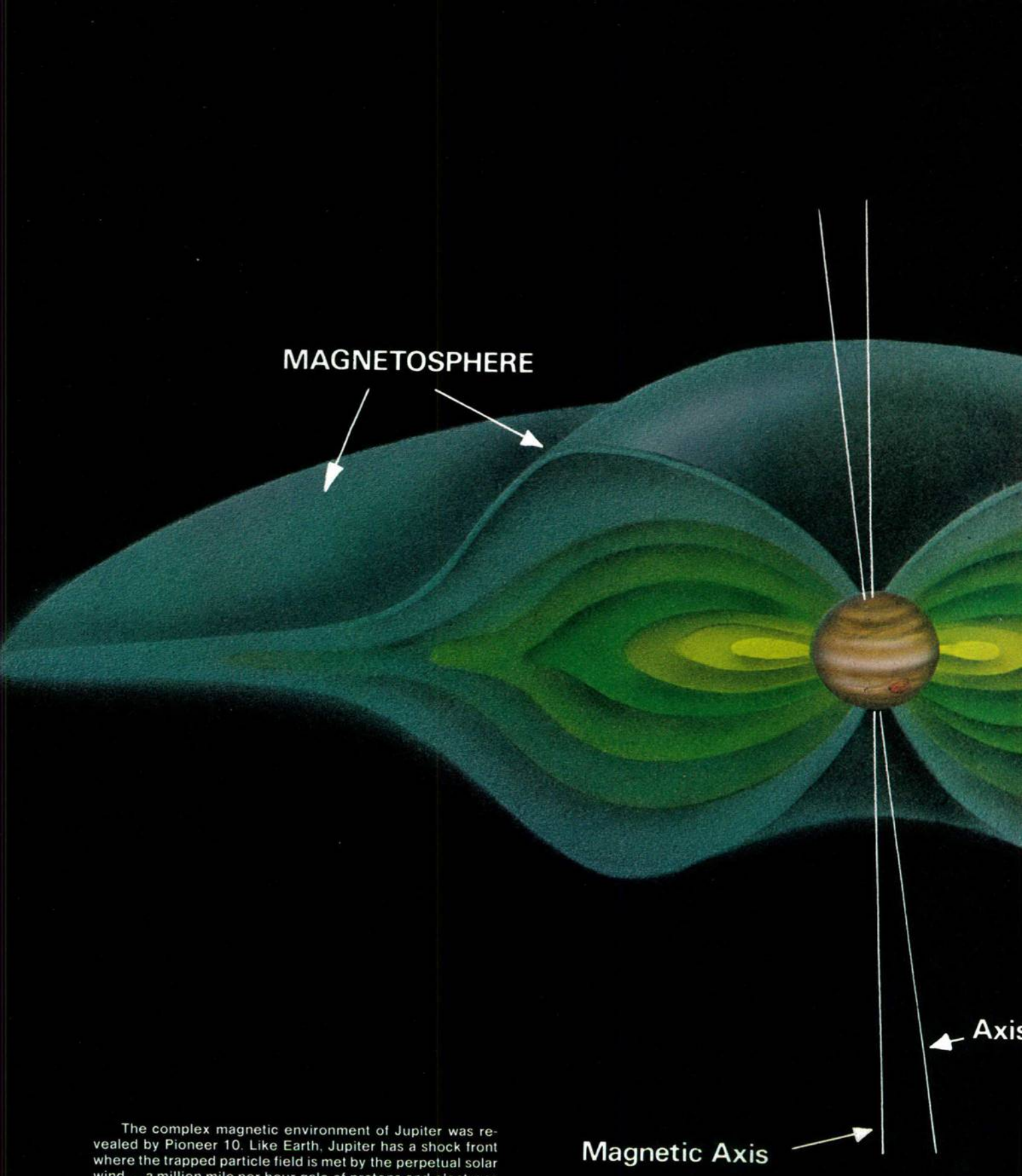
Estimates of the depth of the Jovian atmosphere beneath the cloud layer vary from 60 to 3,600 miles. The precise compositions and interactions of the gases making up the atmosphere are unknown. If the atmosphere is deep, it must also be dense. By one estimate, an atmospheric depth of 2,600 miles would produce a pressure at the Jovian "surface" 200,000 times Earth's atmospheric pressure due to the total weight of gas in the high Jovian gravity. (The "surface" is considered to be the point where atmosphere acts more like a liquid or solid than like a gas.)

Despite a wide variety of opinions on the atmospheric depth, scientists do seem to agree on the presence of liquid water droplets in the atmosphere. Since the planet is believed to have a mixture of elements similar to that found in the sun, it is almost sure to have oxygen. And most of this oxygen has probably combined with the abundant hydrogen as water. If large regions of Jupiter's atmosphere come close to room temperature, and there is no real reason to expect



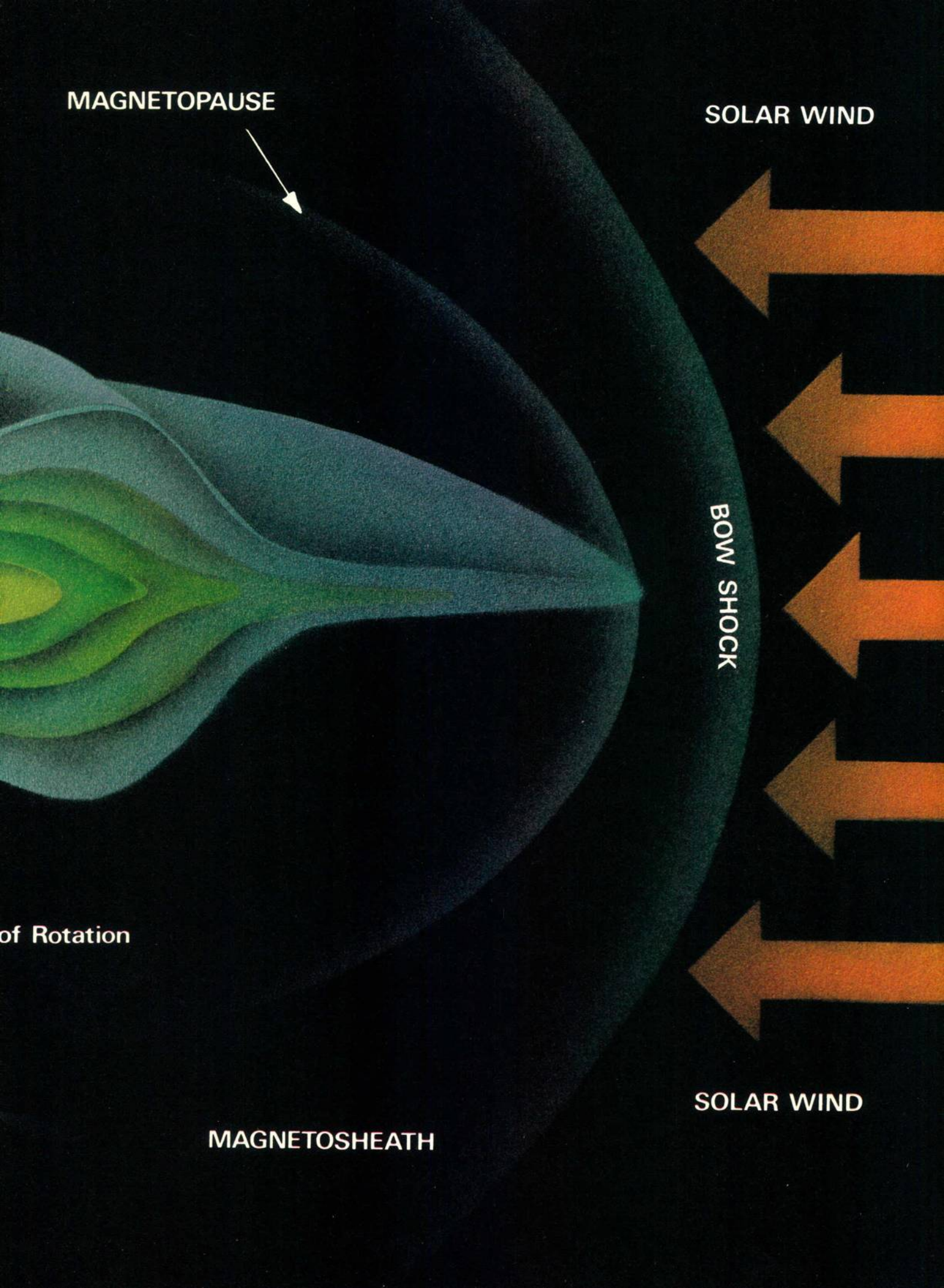
The path of Pioneer 10 has no end. Once past Jupiter the craft is flung, by that planet's enormous gravity, into an unending trek to the stars. It will pass Saturn's orbit in 1975 and cross Uranus' in 1979. By 1984 Pioneer will be beyond the orbit of every planet and on a lonely voyage through interstellar space. (See "Message to the Stars", December issue of ASTRONOMY.)

NASA Diagram



The complex magnetic environment of Jupiter was revealed by Pioneer 10. Like Earth, Jupiter has a shock front where the trapped particle field is met by the perpetual solar wind — a million mile per hour gale of protons and electrons emitted from the sun. The mighty grip of Jupiter's magnetic field encases a huge ring of these energetic particles in a "flying saucer" shaped magnetosphere — the inner portions of which rotate with the planet, but tipped 15 degrees to the axis of rotation. The radiation hazard inside the magnetosphere increases toward the planet's surface. (The scale in this rendering is condensed. The "bow shock" front is actually about 30 Jupiter diameters from the planet itself.)

Artwork by Victor Costanzo


MAGNETOPAUSE
SOLAR WIND
BOW SHOCK
of Rotation
SOLAR WIND
MAGNETOSHEATH

otherwise now with the new temperature measurements, both liquid water and water ice should be present.

Perhaps the most intriguing unknown is the possible presence of life in Jupiter's atmosphere — an atmosphere containing ammonia, methane, and hydrogen. These constituents, along with water, are the chemical ingredients of the primordial "soup" believed to have produced the first life on Earth by chemical evolution. Based on this evidence, Jupiter could contain the building blocks of life.

Some scientists suggest that the planet may be like a huge factory turning out vast amounts of life supporting chemicals (complex carbon-based compounds) using its own internal energy. If so, life could exist without photosynthesis. Any solar photosynthesis would be at a very low level since Jupiter receives only 1/27 of Earth's solar energy. Jovian life would probably be low energy forms (plants and microorganisms) because there is believed to be no free oxygen. Life forms would float or swim because a solid surface, if any, would be deep within Jupiter at very high pressures. (See December ASTRONOMY, page 56, for further details.) Pioneer 10 was not intended to probe the life question.

While there are wide differences among scientists on planet structure, most proposed models contain elements like the following:

Going down, it is believed that temperature rises steadily. Cloud tops may consist of supercold ammonia crystals, underlain by a layer of ammonia droplets, under which may be a region of ammonia vapor. Below this may be layers of ice crystals, water droplets and water vapor. Below this is either the planet's solid surface or liquid hydrogen oceans. Still lower is a region of metallic hydrogen created by high Jovian gravity with perhaps a core of rocky silicates and metallic elements. The core is 10 times the mass of Earth by one estimate. Some theorists doubt that the planet has any solid material at all, but is entirely liquid. Others propose a gradual thickening from slush to more rigid material.

Theorists suggest that Jupiter is almost large enough to be a small star. Because of measurements of excess heat radiated by the planet, current Jupiter theories call for a relatively hot core, compared with earlier ideas of a supercold interior. One hypothesis holds that despite the five billion years since formation of the planets, Jupiter has not completed its gravitational condensation. This continued settling toward the center (as little as one millimeter per year) would produce the required heat energy. If the planet has a rocky core, some of the heating could be from decay of radioactive material in the core.

Internal heat also could explain the magnetic field. A hot core might be a fluid core. Convective and rotational motion of electrically conducting fluids at temperatures of 20,000 degrees may generate the field. Or it could be generated by conductive atmosphere layers below the clouds which would store and later release energy. It is in this particular area — the study of the interaction of Jupiter's magnetic and radiation fields with the planet itself — for which Pioneer 10 was designed.

Among the nine planets only Jupiter and Earth are known to have magnetic fields. Evidence of Jupiter's magnetic field and radiation belts comes from its radio emissions detected over a decade ago by radio astronomers. The only phenomenon known that could produce the planet's decimetric (very high frequency) radio waves is trapped electrons gyrating around the lines of such a magnetic field. When such electrons approach the speed of light, they emit radio waves.

Radio emissions indicate that Jupiter's magnetic field is toroidal (doughnut shaped) with north and south poles like Earth's. Pioneer found the poles to be flipped; a compass would point south on Jupiter.

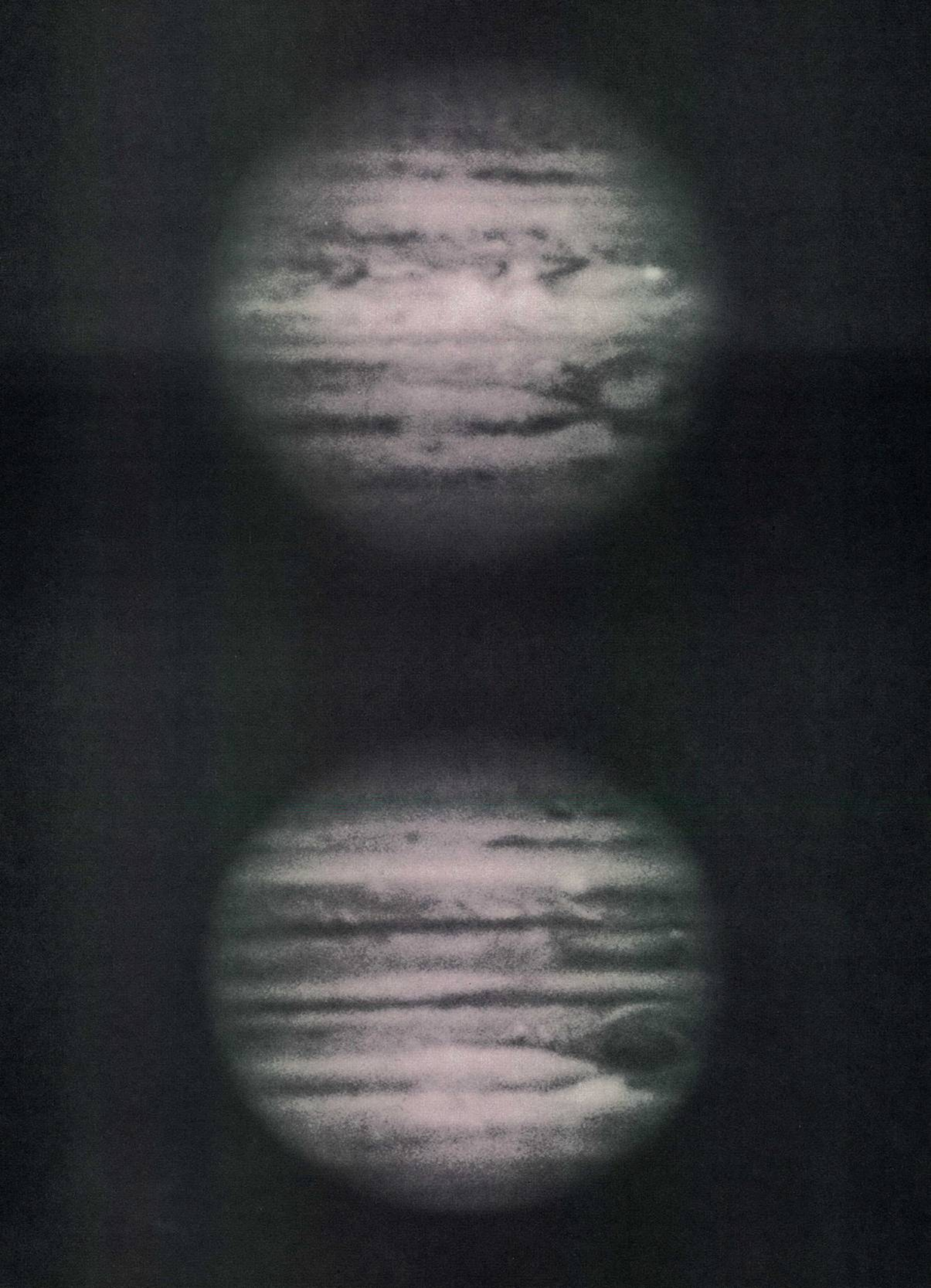
Radio astronomers had estimated Jupiter's magnetic field to be about 20 times stronger than Earth's. Pioneer found it to be 12 times stronger at cloud top levels — a remarkable agreement. The field contains high energy protons (hydrogen nuclei) and electrons trapped from the solar wind. The shape of the magnetosphere — the zone of charged particles trapped by the magnetic field — was mapped by Pioneer 10 as it hurtled past the massive planet.

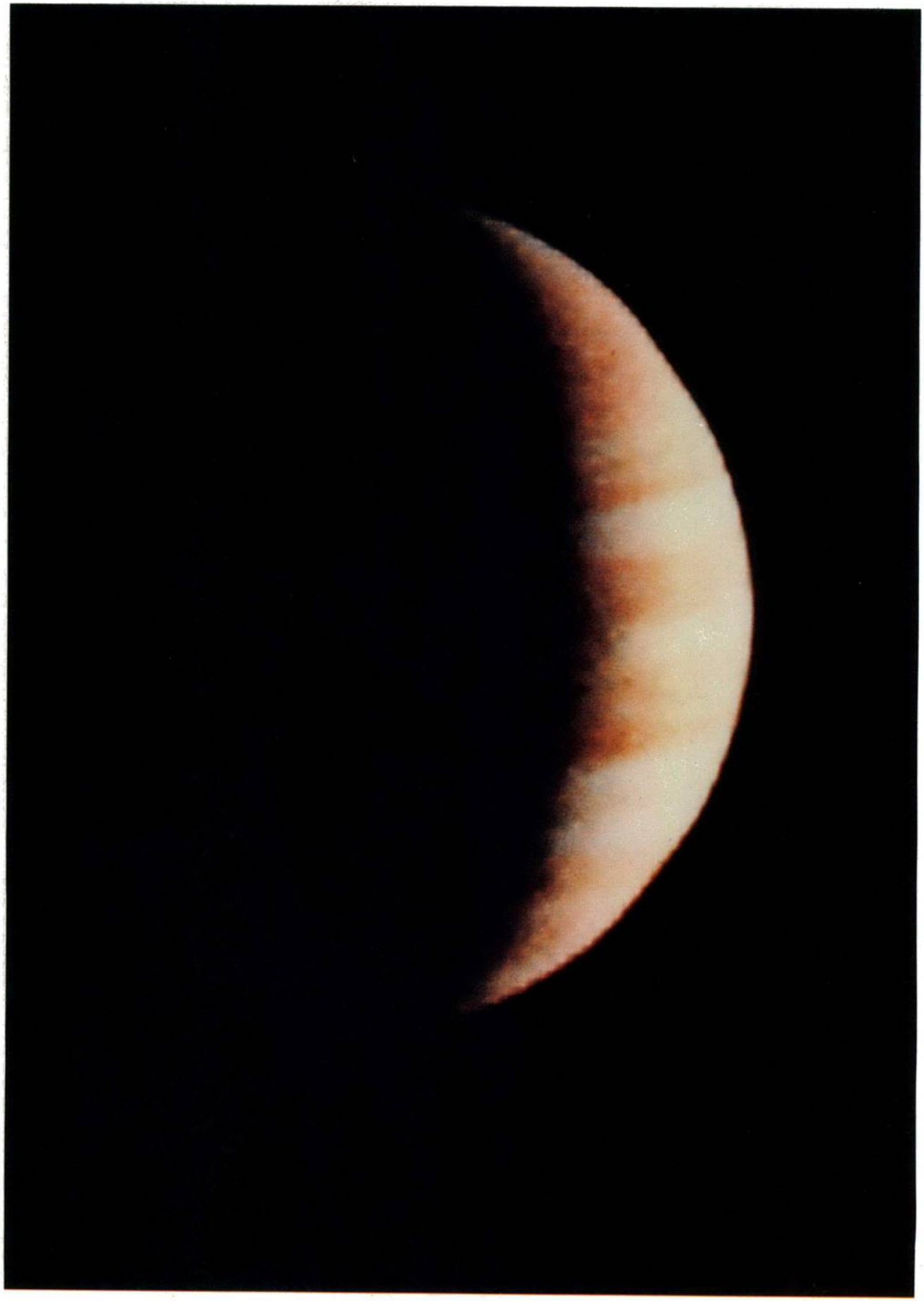
When it was 4.7 million miles from Jupiter, a week before closest approach, the spacecraft encountered a great shock wave where the million mile per hour solar wind produces a "bow shock" front with the planet's magnetic field. (See diagram page 12.) The magnetic field dulls the solar wind to half its former velocity. A resulting surge of energy increases temperature inside the shock front by 150 times.

The real danger to Pioneer was the number

These two images of Jupiter, captured on Jan. 25, 1968 with a 61 inch telescope, were probably the most detailed pictures ever taken of the giant planet with the success of Pioneer 10. The bottom photo shows the planet in visible light. The upper photograph is an ultraviolet image showing higher levels of the Jovian atmosphere. Continent-size festoons mark many regions of the face of the solar system's largest planet. Detail such as this can be seen visually by experienced observers using 12 inch telescopes.

Lunar and Planetary Laboratory Photographs





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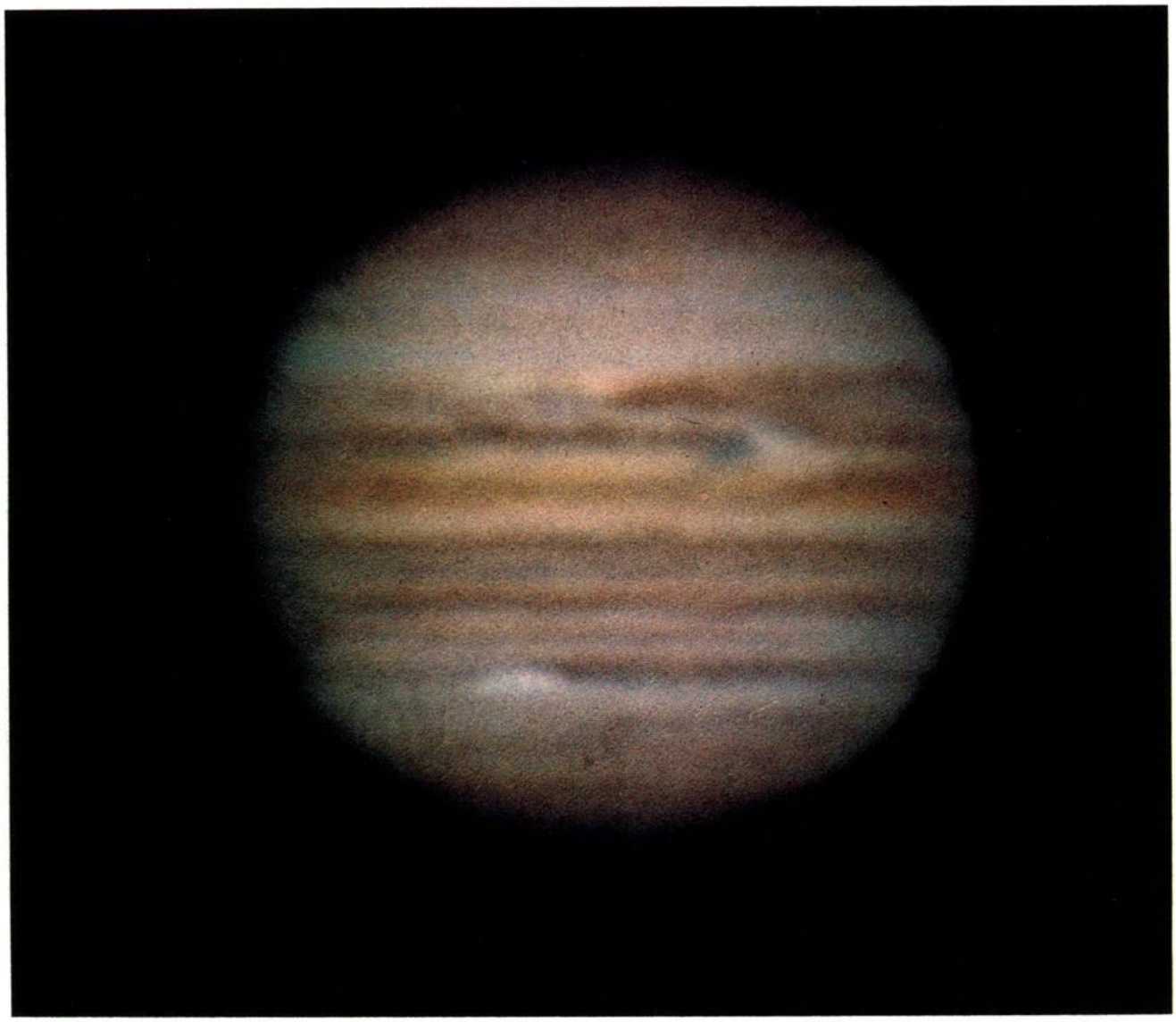


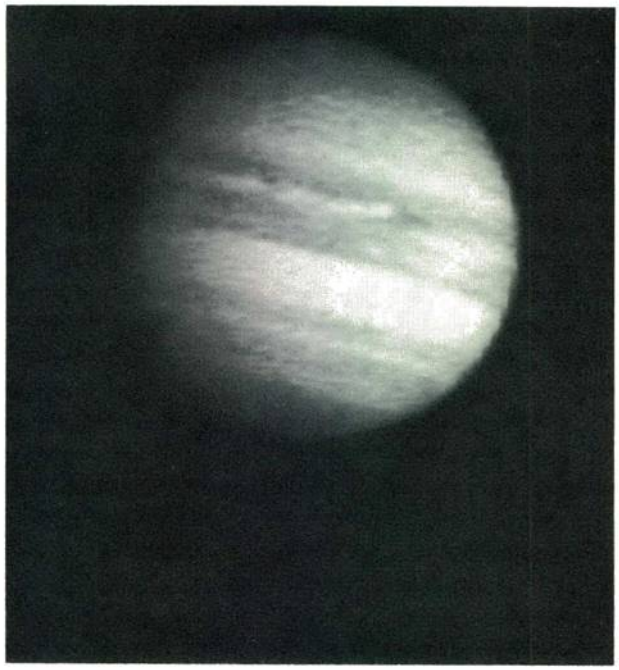
Lunar and Planetary Laboratory Photograph

Until recently, good color photographs of the planets were practically nonexistent. Now pictures such as this are taken regularly at several observatories around the world. Steven Larsen and his associates at the Lunar and Planetary Laboratory in Arizona used a 61 inch telescope for this Jupiter photo, taken April 16, 1968. Notice how the intensity and color of the various belts and zones have changed in the last five years by comparing this picture to the one on page 9.

of protons (hydrogen nuclei) trapped in the field. The outer part of the radiation zone — the magnetosheath — proved to be milder than expected. Within the magnetosheath is the more intense region of radiation forming the magnetosphere. It is held rigidly in the magnetic grip of Jupiter and rotates along with the planet. Yet its outer boundary was found to be "pushed" back toward Jupiter by a wave of high energy particles from the sun. Somehow the field expands and contracts depending on the pressure on it — a phenomenon observed on a smaller scale in Earth's magnetosphere.

This photograph is of a crescent Jupiter as seen by Pioneer 10 as it hurtled away from the planet toward eventual escape from the solar system. The picture was taken on Dec. 5, 1973 when the spacecraft was 1,796,510 miles from Jupiter. The picture clearly shows Jupiter's dark belts and bright zones. This view of the planet, impossible to obtain from Earth, shows what Jupiter would look like to an explorer near Callisto, the planet's fifth moon.

As the little spacecraft from Earth sped deeper into the magnetic field on the day of closest approach the proton count went up a fearsome 5,000 times — nearly, but not quite, enough to disable Pioneer. While close to Jupiter this radiation did wipe out four near encounter pic-



NASA Photograph

These two Pioneer 10 images of Jupiter were taken Nov. 29, 1973 when the craft was more than three million miles from the planet. The red image (left) and blue image (right) can be combined to produce a color photograph such as that shown on page 8. Complex processing has removed distortion caused by spacecraft motion and Jupiter's rotation. Pioneer was only a "scout" for several missions now being planned that will be capable of returning thousands of high resolution photographs of Jupiter and Saturn and the moons of both planets.

tures. Some of the best of the other 336 are shown on these pages. The danger of navigating nearer to the planet was obvious. Pioneer 11, on route to Jupiter, may fly closer but it will be in the upper latitudes, far from the intense equatorial radiation belts. Scientists are not certain it will even be safe there and a final trajectory decision has not yet been made.

Apparently Jupiter's immense gravity has captured a swarm of space dust and debris. Pioneer found 300 times as many meteroids (dust sized particles) in the region immediately surrounding the planet's equator. During this same close encounter phase the spacecraft's imaging system returned pictures of three of the large moons and provided other data on all four.

A major finding of Pioneer is that the density of the moons decreases with increasing distance. The inner of the big four, Io (pronounced E-oh), at 2,273 miles in diameter, is slightly larger than Earth's moon. Our moon's density is 3.3 times the density of water but Io is a surprising 3.5. That makes it the densest major moon in the solar system, far denser than Jupiter or its other big moons. Why this situation exists is not clear. Perhaps Io is a runaway from the inner part of the solar system where denser objects are more common.

Pioneer was targeted to pass behind Io so that its radio signals would be refracted by any atmosphere surrounding the satellite. Sure enough the suspected distortions were detected and an extremely rarified atmosphere, about 20,000 times less dense than Earth's and 70 miles deep, enshrouds this moon. The surfaces of Io and the other moons were found to be near 280 degrees below zero. If Io did come from the inner solar system and was subsequently captured by Jupiter's immense gravity, this thin blanket of air may be a remnant of a more significant atmosphere that is now largely frozen to the ground. There is some support for this suggestion. Io is the most reflective moon in the solar system, so ice and snow could logically be the reflective agents.

Europa at 1,850 miles across is the smallest of the big four moons. Pioneer reported its density at 3.1. Continuing outward, the largest moon, Ganymede (see Astro-News) had its density measured at 1.9. Finally Callisto weighed in at 1.7 times the density of water. All of these figures are different by several percent from those determined previously by earthbound techniques.

Its mission largely completed, Pioneer 10 has now been flung by Jupiter's enormous gravity on a flight to the stars. The tiny robot space voyager is man's first attempt to probe the mysteries of worlds far stranger than we can imagine.

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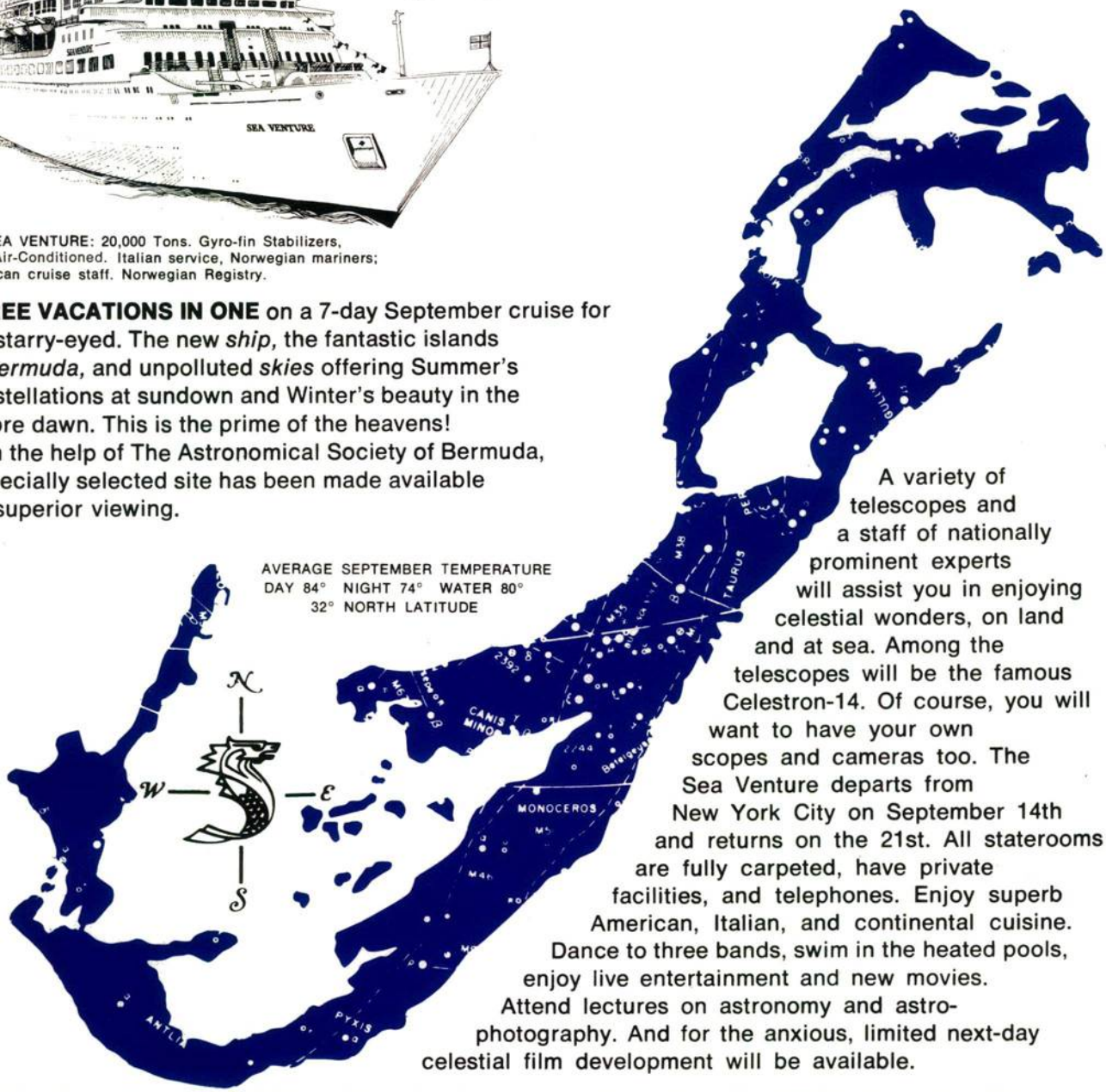

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PHOTOGRAPHY IN ASTRONOMY

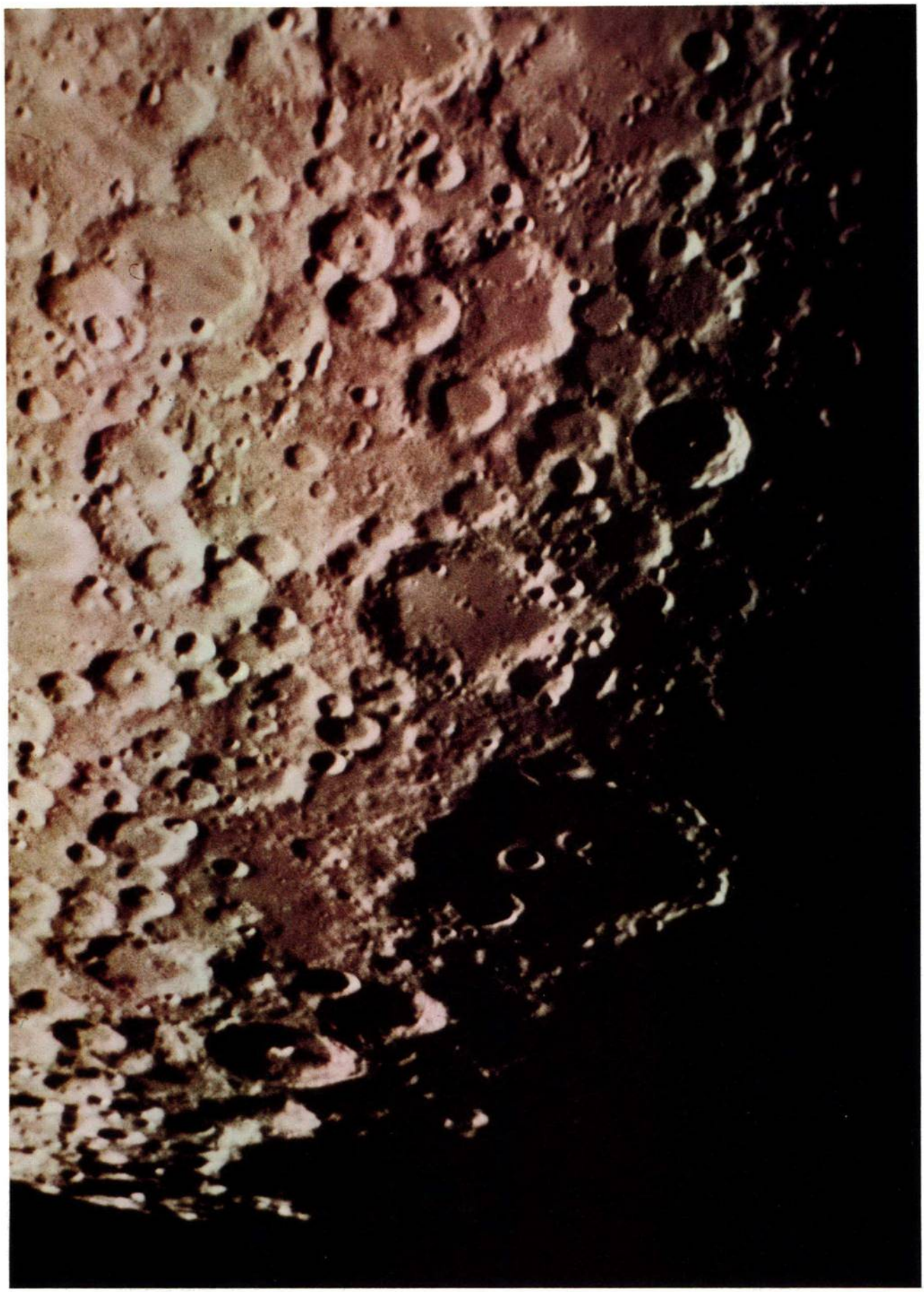
Moon and Sun Photography — Easy and Satisfying

by
John Sanford

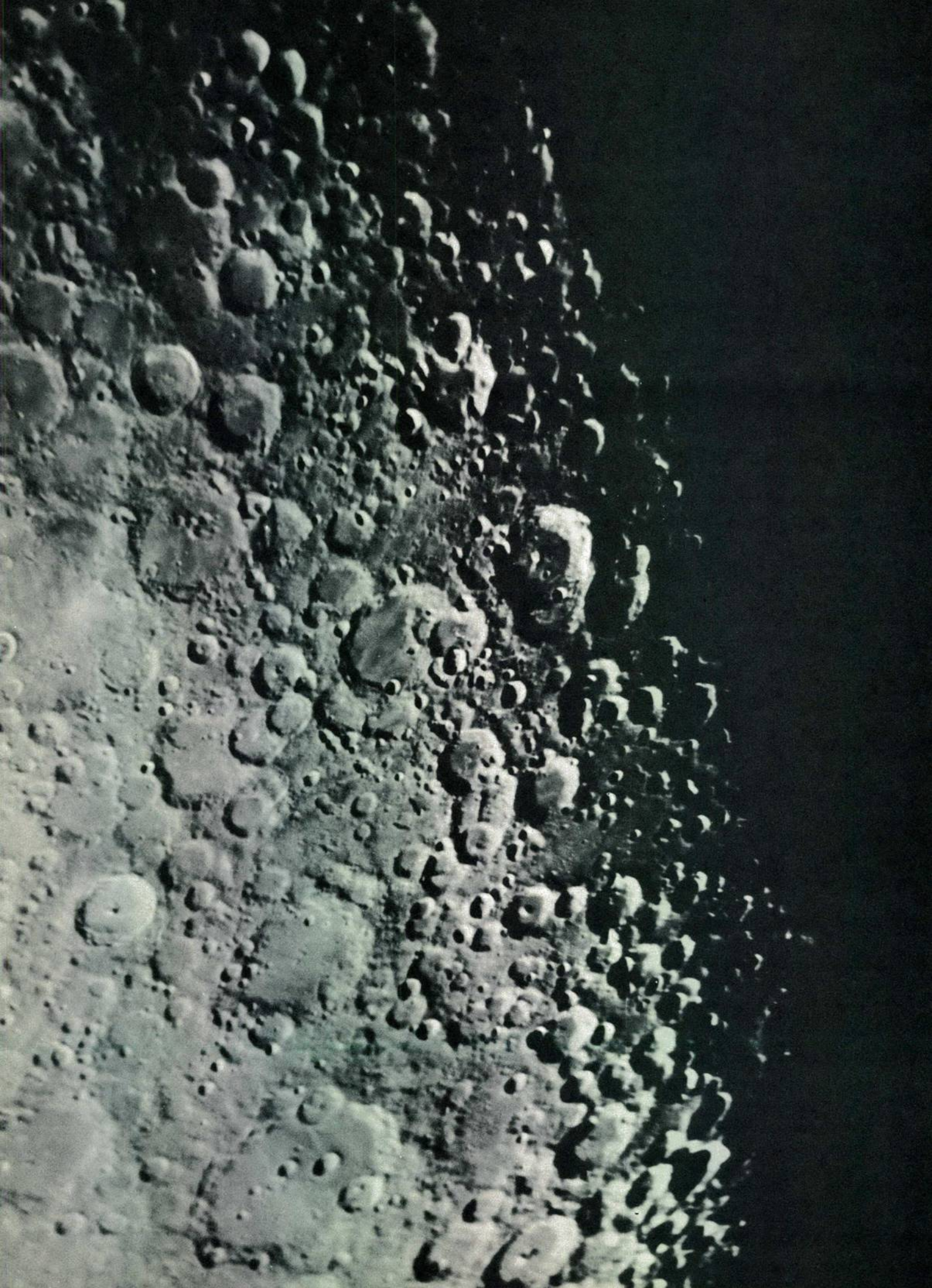
The first sky photographs ever taken were pictures of the moon made in 1840 by Dr. John Draper. He used the newly invented daguerreotype process with a three inch lens to produce indistinct images with exposure times on the order of 30 minutes. Today, the moon offers one of the easiest yet most challenging subjects for astrophotographers. Any telescope — even a telephoto lens — can be used to get satisfying pictures of our natural satellite. Aside from surface detail, the crescent moon presents beautiful scenic compositions, when earthshine illuminates the side facing us. And of course, a lunar eclipse offers a quickly changing event than can be recorded in its entirety during one six hour period. Since the next major lunar eclipse is over a year away, the normally illuminated moon will be our photographic target for now.

Color photographs of the moon taken in the early evening at thin crescent phases can be very beautiful, especially if they are exposed to show

The south quadrant of the moon — the region around the craters Tycho and Clavius — was captured in detail on High Speed Ektachrome film. The one second exposure and eyepiece projection method on a six inch reflector combined to produce observatory-quality results.



Photograph by John Sanford



earthshine. Sometimes it is possible to include a portion of a tree or a church steeple as foreground to improve the composition. Even a moderate telephoto lens, 105mm to 135mm in focal length, is enough magnification for this type of shot. The brightness of earthshine will vary from month to month depending on cloud cover on the side of Earth facing the moon. Early morning is the best time to make this kind of picture, because the sky is usually clear and free of dust and smog. The length of exposure needed to record earthshine before the moon blurs, due to Earth's rotation, will depend on the lens or telescope focal length. As a result, unless a driven equatorial telescope is used, fast film such as High Speed Ektachrome or GAF 200 or 500 should be used so exposures can be kept to a few seconds in length. If a 400mm or longer lens is used, exposures should not exceed two seconds. Since earthshine is quite faint, the photographer should "bracket" exposures; that is, give several longer and shorter exposures than the best guess.

Even more satisfying is a good shot of the moon taken through the telescope — using the scope as the camera "lens". This requires an adapter. If you have an SLR (single lens reflex) camera the correct adapters can be purchased from Mr. John A. Scharff, Edmund Scientific Co., 101 E. Gloucester Pike, Dept. 2A, Barrington, NJ 08007. Specify type of camera and diameter of eyepiece holder (either 1-1/4 inches or 0.96 inches). Prices vary depending on size and type but average $15. The adapter will allow you to insert your camera into the eyepiece tube so the prime focus image of the moon will fall on the focal plane of the camera. With this setup you are ready for the easiest and most fun part of telescopic lunar photography — recording the moon's changing phases.

Almost any telescope will do, since the moon is bright enough to take with "snapshot" exposures. The best exposure method is to frame and focus the image, then hold a black card in front of the telescope. Set the shutter on "B" or "T" (B needs a locking cable release). Pause for a few seconds to let any vibrations in the telescope quiet down, and then expose by pulling the card away from the sky end of the scope for the required time. Exposures in the range of 1/4 second may be made this way with a little practice. Film can be relatively slow, fine grain types such as Kodachrome II for color and Panatomic-X for black and white. If the telescope has a focal length of 80 inches or more, the image of the entire lunar disk may not fit on the short dimension of the 35mm frame, and a larger camera may be required to get it all in (especially with a full moon). If the telescope has a drive, it should be running during photography for maximum sharpness of small detail.

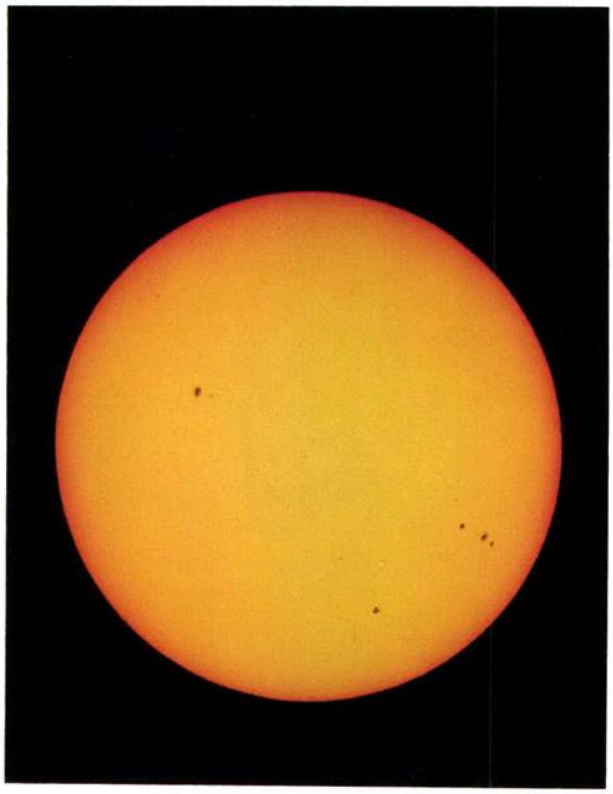
The recently introduced 2483 Ektachrome Micrographic film has the finest grain color emulsion commercially available and is excellent for lunar work. Tests show it has about twice the resolution of Kodachrome II. There is a tendency for this film to record the moon as rather blue, so a corrective filter may have to be adopted after tests. For black and white there is also a new film which has been on the market for a year or two, called SO-410. This film is a panchromatic, very fine-grain emulsion, which is nominally rated at from ASA 64 to 200, depending on the strength of development. For our use, it is even better to derate it to ASA 40 and develop in a compensating developer such as H&W Control or Acuspecial. Doing so will result in fine negatives capable of great enlargement without appreciable grain.

One problem which sometimes plagues whole-disk lunar photography is the differences in brightness between the terminator area (where the long shadows and delicate details show up best) and the rest of the illuminated disk. Most modern color films are capable of accepting such large variations. Experiment for best results.

Close-up photography of individual craters, mountains, and other formations on the lunar surface is a more challenging task for the astrophotographer. It requires an eyepiece projection arrangement that is recommended only to those who have succeeded at whole disk techniques. And there is an additional factor working against the photographer — seeing. Seeing is the term used to describe the "steadiness" of the image. Blurring caused by atmospheric turbulence degrades the seeing. Good seeing is desirable but less frequent than fair or poor quality seeing. In excellent seeing the telescope will resolve detail to the theoretical limit. With an eight inch telescope, the theoretical resolution at the moon's distance will be about 1/2 mile, with 1/2 second of arc seeing. Rarely will the air be more tranquil than that, and most nights it will be on the order of two to three seconds of arc. This means that the telescope will rarely achieve theoretical visual resolution. The situation is even worse photographically because the time span of the exposure allows

The crater Tycho is near the lower left edge of this photo by eyepiece projection with an eight inch telescope. Kodak High Contrast Copy film was exposed for 1/2 second and developed in H & W developer at 75 degrees.

Photograph by Stephen Reed



Photograph by John Sanford

At the prime focus of his eight inch Schmidt Cassegrain John Sanford used Kodachrome II for a 1/60 second exposure of the entire disk of the sun on June 1, 1972. Sunspots are at their minimum in 1974 but will be increasing in numbers for the rest of the decade

more blurring due to turbulence in the air. Typically, a good lunar photograph will show detail two to four times the theoretical limit for a given aperture, with a seeing-imposed limit on telescopes larger than 12 inches of about 1/2 second of arc. Generally, what can be seen in a three inch telescope requires a six inch to photograph.

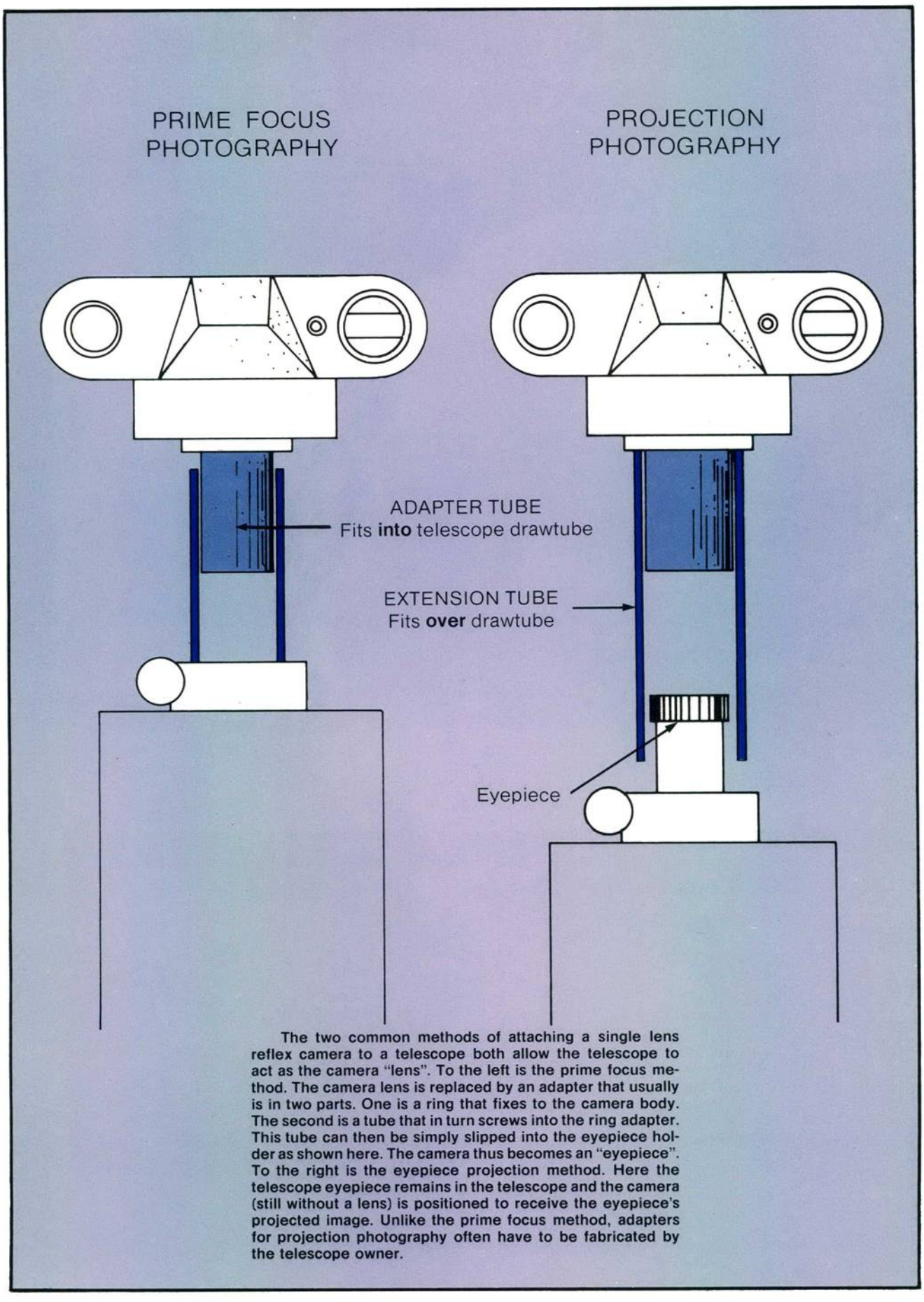
Since the shortest exposures are desirable to minimize seeing problems, a fast film such as Tri-X or GAF 200 or 500, or High Speed Ektachrome should be used. A good method for the amateur is the camera off telescope procedure. An SLR camera is necessary, along with a sturdy tripod. The camera is set up beside the telescope with the eyepiece projecting into the camera with the lens removed. It is important at this point to make sure that the direction of movement of the eyepiece end of the telescope (by the sidereal drive) is either directly toward, or directly away from the camera. This is so that the image will not traverse across the film during the exposure. The only effect will be a slow change of focus which will not affect the picture during the short exposure period (one to four seconds). Exposures are made in bursts of two or three, then refocus and shoot again. It may help to put an extension tube on the camera to keep out stray light, or you can work under a dark cloth. One thing to keep in mind: if the seeing is not good, you will not achieve fine results. Photograph when the moon is high in the sky to minimize the amount of atmosphere traversed by the moon's light.

The first recorded solar photograph was made in 1845 by physicists Fizeau and Foucault. The exposure of the unfiltered sun was 1/60 of a second on the extremely slow daguerreotype plate. This is one indication that the sun is very bright (the moon took 30 minutes on the same plates). In any kind of solar observation except during a total solar eclipse, great care should be taken to protect the observer's eyes from potential damage from both visible and invisible infrared rays. The retina of the eye has no pain sensors, so it is possible to sustain burn damage there very quickly and without the instant protection that pain affords. Today there are several brands of solar filters which are effective and inexpensive. The best is the type which reflects away 99.999 percent of the radiation by means of an aluminum or nickel coating on glass or thin plastic placed in front of the objective lens or on the sky end of the reflector. (See the November issue of ASTRONOMY for details.) Also, remember to do something about the finder telescope if your instrument has one; many shirts sport a burned spot because the finder was neglected!

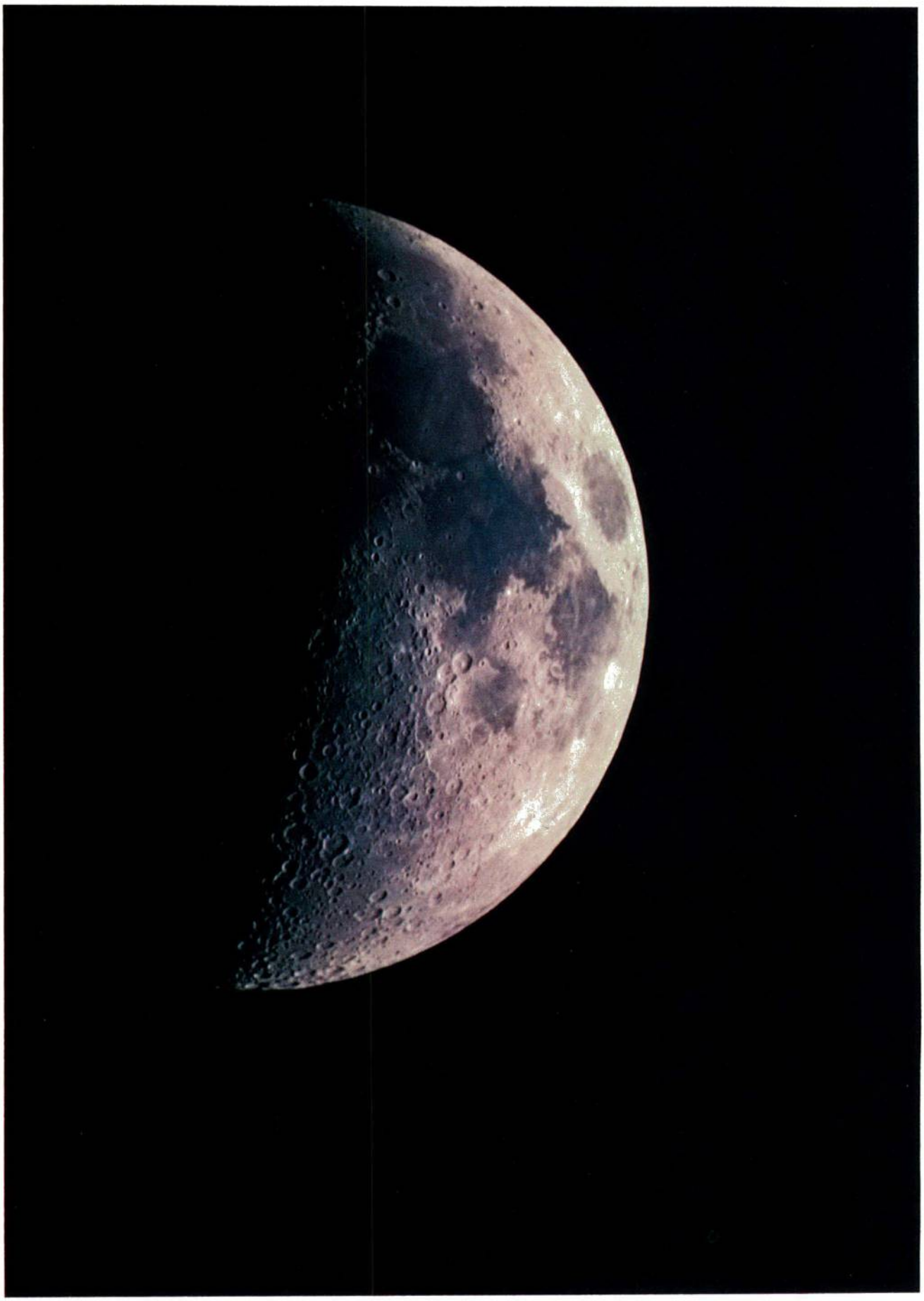
Photography of the sun requires approximately the same techniques as lunar work since

Photograph by John Sanford

Earthshine, reflected sunlight from Earth faintly illuminating the night side of the moon, is shown in this photograph. The moon was two days old when John Sanford attached a 500mm lens to his SLR camera, mounted the camera on his telescope to utilize its sidereal drive, and took this six second exposure on GAF 200 film.



The two common methods of attaching a single lens reflex camera to a telescope both allow the telescope to act as the camera "lens". To the left is the prime focus method. The camera lens is replaced by an adapter that usually is in two parts. One is a ring that fixes to the camera body. The second is a tube that in turn screws into the ring adapter. This tube can then be simply slipped into the eyepiece holder as shown here. The camera thus becomes an "eyepiece". To the right is the eyepiece projection method. Here the telescope eyepiece remains in the telescope and the camera (still without a lens) is positioned to receive the eyepiece's projected image. Unlike the prime focus method, adapters for projection photography often have to be fabricated by the telescope owner.



Photograph by John Sanford

Photograph by John Sanford

For this close-up of a sunspot group John Sanford used a full aperture filter and eyepiece projecton with his six inch Newtonian reflector. The surface granulations and details in and around the spot can all be seen visually through a properly filtered telescope. This sunspot region is larger than the Entire earth.

the filter brings the sunlight down to similar levels of intensity. Some SLR cameras allow the mirror to be locked up in advance of the exposure. (This will allow photography without the "hat trick" technique.) Lock the mirror up after focusing and framing, and then use the self-timer set for the shutter speed you desire. The self-timer's delay will allow the telescope to quiet down before the actual shutter is released. Shutter speeds will of course vary with the f/number of the instrument, filter and film used. Experiment with several exposures for best results.

The waxing moon, a few days before first quarter, was photographed on Kodak's fine grain SO-456 film at the prime focus of an eight inch Schmidt Cassegrain telescope. Exposure times for lunar photographs vary with phase and atmospheric transparency. Try a range of exposures for best results.

The brightness of the image allows use of a fine-grained emulsion such as Panatomic-X or SO-410 in black and white, or Kodachrome II in color. You may wish to adjust the color of your solar slides since some of the recently introduced filters (Solar-Skreen) produce a distinctly bluish image. Color correction filters available at many photo stores can adjust the color to more pleasing tones. To find the correctional filter needed, take your slides to the photo shop and look at them through the color correction filters until you find the one you think corrects best. Placed in front of the camera in the telescope setup, it should provide the color correction you want when shooting the next roll of film. Such photographs of the sun will show the limb darkening phenomenon, the spots, and faculae (brighter areas near the limb). On days of good seeing, the granulation of the photosphere will also be recorded.

Exploding Galaxies

by
Gerrit L. Verschuur

Since we are located in a nice quiet galaxy known locally as the Milky Way, we are able to live on our planet and study the universe around us at our leisure. At least, so far we have been able to do so! But this is not so for those unfortunate beings living on a planet in a galaxy which suddenly undergoes an enormous explosion.

In their examination of distant galaxies, astronomers have found many that actually have undergone explosions on a galactic scale. Some of these explosions have torn entire galaxies apart. In other instances observations show two enormous blobs of matter streaming away from a central explosion. In most cases observed so far, the explosion did occur in the center of the galaxies in question, and often two clouds of energetic particles are thrown out in opposite directions giving rise to the now well-known phenomenon of double radio sources. These exploding galaxies are usually observed by the radio emissions they generate in the two ejected clouds of matter, rather than by a search of sky photographs.

Some exploding galaxies can easily be seen optically. The best known one is the galaxy M-82 in the constellation Ursa Major. This one has not evolved to the characteristic double configuration, perhaps because the explosion is actually occurring in that galaxy at this time. On page 29 is a photograph of M-82 and the filamentary matter radiating away from the main disk of stars and dust. This material has been shown to be moving at high velocities, many thousands of miles per second.

The elliptical galaxy M-87, in Virgo, is an example of a galaxy that has exploded but is apparently only ejecting material in one direction. Violent, chaotic events have generated strong magnetic fields and highly energetic particles

At a distance of seven million light-years, this relatively nearby exploding galaxy (M-82) suffered a major eruption at its core some two million years ago. Matter, flung out from the galaxy's nucleus at over one thousand miles per second, has now reached about 15,000 light-years from the site of the explosion. The likelihood of such violence occurring in our galaxy seems remote.

Hale Observatories Photograph

in and around M-87, making it a "bright" object in radio telescopes. Traveling at almost the speed of light, these energetic particles encounter the magnetic fields and spiral about the magnetic field lines. In so doing, they radiate away some of their energy in the form of radio and light signals. This makes them detectable on Earth as a distant source of radio emission.

M-87 is one of a class of objects known as radio galaxies (as in M-82). In the right part of the photograph on page 31 , we show M-87 and the luminous jet radiating from it; the quasar shown left of M-87 also shows a jet of matter projecting from it. While the quasar is at a distance of about one and a half billion light-years, the photograph shows that these two objects are superficially similar. However, the quasar is a hundred thousand times more luminous than M-87, so it is very clearly a different type of object. Yet the two, when viewed in comparison, look similar. Without a doubt similar processes must have occurred in these two objects to produce the enormous explosions required to send the jets of matter out into space. The jet in quasar 3C273 is about 150,000 light-years long, while the one in M-87 is only 3,000 light-years long. The similarities and differences between this radio galaxy and quasar might give clues about the true nature of quasars.

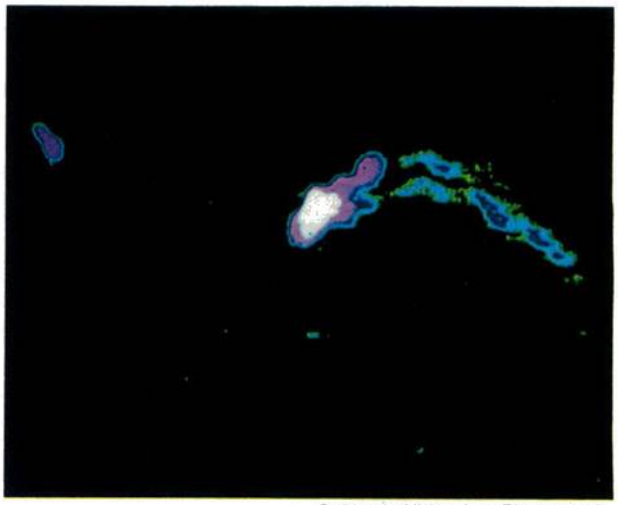
Explosions in distant galaxies and quasars are quite harmless to us since the cosmic rays produced there will never reach us. We only pick up their highly diluted radio and light signals with our largest telescopes. However, if such an explosion were to occur in our galaxy it would probably wipe out life on our planet — the enormous excess dosage of cosmic ray particles (high energy protons and electrons) would be fatal. It is unlikely that such an explosion will ever occur in the Milky Way however, because our galaxy does not appear to be of the type that is susceptible to an explosion on such a large scale.

Many radio galaxies (galaxies that have undergone explosions of some sort and are detectable as strong radio emitters) are elliptical galaxies, and usually the largest elliptical in a cluster of galaxies. Our galaxy is a spiral galaxy and is unlikely to become a radio galaxy. Nevertheless, the nucleus of the Milky Way system does have many of the characteristics of a very small elliptical galaxy in terms of its stellar content. A study of gas motions in the direction of Sagittarius — the direction of the center of the Milky Way — has provided evidence that a small explosion may have occurred at some time in the past in the center of our galaxy. This explosion was not strong enough to influence us at our distance from the center (30,000 light-years).

Recently, another fascinating form of exploding galaxy has been studied by astronomers. This is a type of galaxy known as a head-tail galaxy. The first was discovered by radio astronomers in Cambridge, England and later studied in detail in Holland.

A radio photograph of a head-tail radio galaxy together with a smaller companion radio galaxy is shown on this page. This is actually a

Westerbork Radio Observatory Photograph



Colorado Video Inc. Photograph

A twin tail streams behind the exploding galaxy 3C129 as seen in this radio photograph at left. The tail is thought to be a trail left by the exploding galaxy as it moved through a relatively dense region of intergalactic particles within a cluster of galaxies. (The background pattern of lines is produced by the radio telescope.) On the right is the same object artificially colored so that each color represents a different intensity of radio emission. The "tail" is known as radio source 3C129.1. The object, to the left in both photos, is a smaller radio galaxy in the same cluster.

Hale Observatories Photographs

These two objects look similar but are actually very different. The right photo is the giant exploding galaxy, M-87; left is quasar 3C273. Both have protruding jets emanating from them. The problem is that the quasar is 100,000 times as luminous as M-87 and is an entirely different type of object even though they look the same. Are the explosive mechanisms the same in both cases? An understanding of this enigma will certainly be a major breakthrough.

photograph of a map produced by displaying the intensity of the received radio signals on a cathode ray tube where the brightness is a measure of the intensity of the received radio signals. This "radio graph" as it is called was made at the new Dutch radio observatory at Westerbork and shows the pair of radio sources known as 3C129 and 3C129.1. The main component, 3C129, shows a long radio tail or stream stretching out from the main nucleus. An optical photograph of this part of the sky shows a galaxy located at the tip of the head of the radio source.

It is thought that the galaxy underwent an explosion which ejected two large clouds of matter into space, again in two opposite directions, similar to the better known double radio sources. However, in this case the galaxy was moving very rapidly through space, at several thousand miles per second. In addition, there must be material in intergalactic space around 3C129 that acts like a ghostly cosmic wind blowing past the rapidly moving galaxy. As the two blobs of material move out into the surrounding space, the wind sweeps them back in what could be called the wake of the galaxy. In addition, it is thought that the parent galaxy is also rotating so that the two ejected clouds are twisted into a helical shape almost like two corkscrews stretching out behind the galaxy. This explains the double and twisted structure in the tail.

The color photo of these radio galaxies is not a true picture either, but was produced with a video quantizer. Here, the different intensities of the radio emission have been represented by various colors, arbitrarily chosen. The photograph beautifully illustrates the structure of this head-tail galaxy. The other smaller object is probably a similar, but weaker, radio galaxy in the same cluster of galaxies of which 3C129 is a member.

The curved tail of 3C129 appears to be over one million light-years long. An estimate of the age of this object suggests that the explosion started 200 million years ago.

The enormity of these galactic explosions is quite beyond comprehension — their violence defies comparison. But we can at least feel secure in the knowledge that we are drifting along on a planet that is a citizen of a normal galaxy.

FEBRUARY

Stars in each constellation are indicated, in order of brightness, with the Greek Alphabet.

α	Alpha	η	Eta	ν	Nu	τ	Tau
β	Beta	θ	Theta	ξ	Xi	υ	Upsilon
γ	Gamma	ι	Iota	o	Omicron	ϕ	Phi
δ	Delta	κ	Kappa	π	Pi	χ	Chi
ϵ	Epsilon	λ	Lambda	ρ	Rho	ψ	Psi
ζ	Zeta	μ	Mu	σ	Sigma	ω	Omega

MAGNITUDES

- Zero
- First
- Second
- Third
- Fourth
- Fifth

OBJECTS

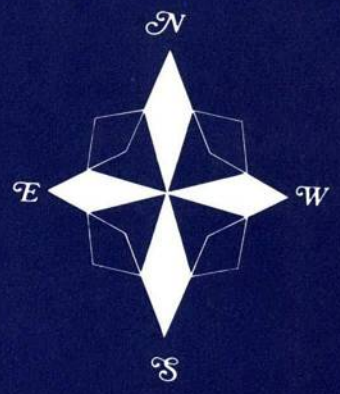
- Open Clusters
- Globular Clusters
- Diffuse Nebulae
- Galaxies
- Double Stars
- Variable Stars

Map by Raymond G. Coutchie

Star Dome approximates the sky as it appears at 9 p.m. Local Standard Time on the first day of the current month. The same constellations are visible one hour earlier on the 15th. To use this constellation finder, hold it overhead so the compass points line up with North, South, East and West in your backyard or viewing area. For example, to find constellations in the southern part of the sky hold the chart in front of you so the South compass point faces the southern horizon. Repeat this procedure for East, West and North. Since only the brighter stars are represented in this map, you should be able to trace out the geometrical shapes of the contellations with ease. To find planets, asteroids, etc., visible among the current month's zodiacal constellations, refer to the planet finder in Sky Almanac.

STAR DOME

Map Centered on 43° North Latitude



by
John G. Harmon

Dominating the winter sky from its position astride the celestial equator is the constellation Orion, the Hunter. This constellation dates back to at least 2000 B.C., when the "belt stars" could be seen rising just before the sun during the month of June. This month was called "Tammuz" by the Chaldeans, a name which they also applied to Orion itself. There is some evidence that the constellation may date back as far as 4667 B.C., when Orion marked the Equinoctial Colure, a great circle passing through the equinoxes and poles.

The rising of Orion was often used to mark the beginning of various seasons. Rising in the morning, it heralded the beginning of summer. It is in this context that we find it referred to in Hesiod's **Works and Days**.

"Forget not, when Orion first appears,
to make your servants thresh the sacred ears."

Similarly, grapes were gathered when Orion rose at midnight, and preparations were made for

winter when Orion appeared in the evening.

Legends concerning Orion are as varied as the cultures from which they come, but the stars are usually said to represent the large figure of a man. Babylonians saw Orion as their first king, Merodach. He was represented in his struggle with Tiamat, who was said to be represented by the constellation Cetus.

In contrast with this godlike and noble view of Orion, the Hebrews saw the group as a "Kesil", or fool, who was pictured in the sky as standing on a rabbit (Lepus) and pursuing a flock of doves (the Pleiades).

The traditional Greek view of the constellation is more like that of Hebrews than the Babylonians. Orion was thought to be chasing the seven sisters or their mother across the sky, but was blocked by Taurus, who was shown charging toward him. Orion, in turn, was shown in a defensive posture with an upraised club in one hand, and a lion skin as a shield in the other.

The Greeks had a number of other legends about Orion and his exploits. According to one story, Orion wanted to marry Merope. In this case, Merope was not one of the Pleiads, but was the daughter of King Oinopion of Chios. The king opposed the marriage and Orion decided to elope with Merope. Discovering the plot, the king offered Orion some drugged wine. (Chios was noted for its wine, and the name Oinopion means "wine-face".) After the wine had taken effect, the king put out Orion's eyes and cast him out by the sea.

Orion then made his way to the forge of Vulcan by following the sound of the god's hammer. Vulcan summoned a Cyclops who carried Orion to the top of a high mountain, and left him there facing the East. As the first rays of the rising sun fell upon him, Orion's sight was restored.

A sidelight to this story tells us why the dawn is red. Aurora, the dawn, preceded the sun into the sky. Upon seeing Orion standing naked on the mountaintop, Aurora blushed, and continues to do so to this very day.

Another legend concerns Orion's death and placement in the sky. Orion was a mighty hunter, and claimed that he could conquer any animal on Earth. To punish him for his vanity, the gods caused a giant scorpion to grow out of the ground. The scorpion stung Orion on the foot and killed him. Orion was then placed in the stars at the request of Diana. The scorpion, represented by Scorpio, was also placed in the sky opposite Orion. This arrangement allows one to set as the other rises.

The Arabs knew Orion either as Al Jabbar meaning "the giant", or by the earlier title Al Jauzah. The exact translation of this latter name is not clear, but "the central one" seems to be a fairly close rendering. Originally, the term meant a black sheep with a white spot on the middle of its body.

The names for Orion's bright stars come to us from the Arabs as well. Alpha Orionis is known as Betelgeuse, perhaps the most humorous of all star names. It is pronounced as if it were "beetle juice", and is derived from the Arabic Ibt al Jauzah, meaning "the armpit of the central one". Betelgeuse is a red super-giant star approximately 200 million miles in diameter — larger than the orbit of Earth!

Beta Orionis, or Rigel, is actually about one-third of a magnitude brighter than Alpha. The name comes from Rigl Jauzah al Yusra, the "left leg of the central one". It is a hot, bluish star 150,000 times brighter than our sun.

Gamma is Bellatrix, the female warrior or Amazon star. Astrologically it signified loquaciousness, or as Thomas Hood put it, "Women born under this star shall have mighty tongues."

Mintaka, or Delta, lies almost directly on the celestial equator. Its name means "the belt", and it is the brightest of the three that mark that line. The others are Alnilam (Epsilon) and Alnitak (Zeta). These three stars were sometimes referred to separately, in addition to being part of Orion. In this context they have been called: the weighing beam, Jacob's staff, the three seal hunters, young men dancing a Corroboree, the yardarm, the ell, and the magi or three kings.

Orion's belt slants toward Kappa or Saiph. The name is derived from Al Saif, the sword — a name that really belongs to Eta Orionis. Originally the star was more accurately known as Rigl Jauzah al Yamna, the "right leg of the central one."

Hanging from Orion's belt is his sword, at the center of which is the famous Great Nebula. This giant cloud of gas is just visible to the unaided eye and covers the same space as the apparent diameter of the full moon. There is fainter nebulosity around it that covers an even larger area.

The nebula is a birthplace of stars with more than a thousand already catalogued within it. It was apparently overlooked by Galileo and was first seen telescopically by Cysatus of Lucerne in 1618. It was again observed in 1656 by Christian Huygens, who referred to it in his **Systema Saturnium.** The Great Nebula was also the first to be successfully photographed, by Professor Henry Draper on Sept. 30, 1880.

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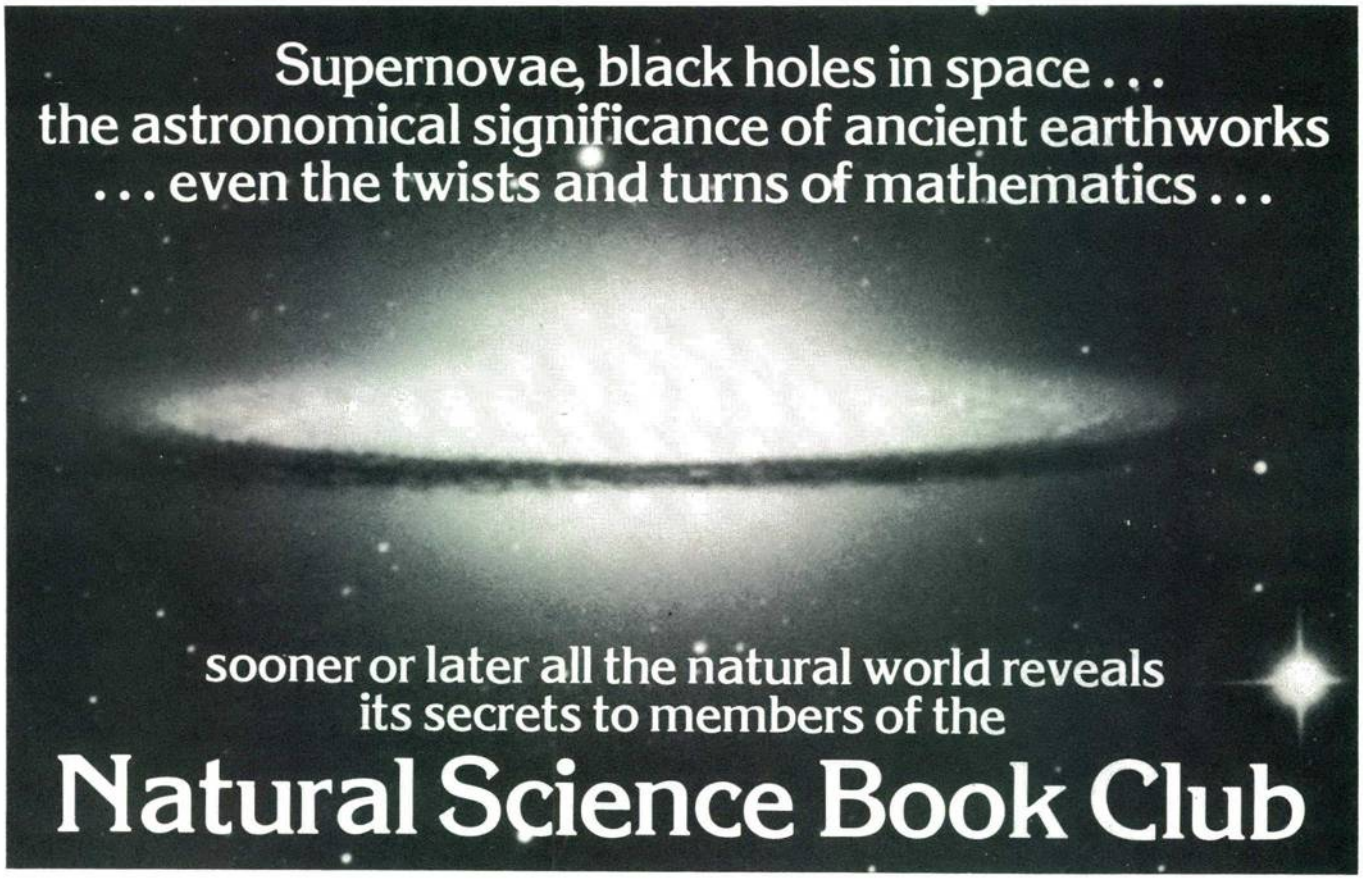
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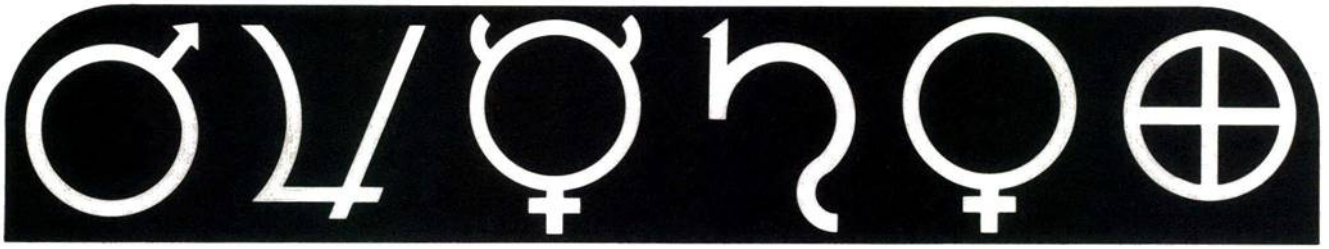


Saturn Highlights a Diminished Sky Show

With Comet Kohoutek rapidly fading and Jupiter and Venus removed from evening viewing, the sky watcher who braves the winter elements will find a few items of interest — though not as many as earlier this season.

Saturn

The ringed planet tops the observer's list in February since it is high in the sky at dusk and remains well up all evening. A telescope magnifying 30 times or more should show the famous rings.

The same telescope may show Titan, largest of the planet's 10 moons. In small telescopes Titan can be seen to the east of Saturn for a few days around the 12th and 28th, and to the west around the 4th and 20th. Titan orbits Saturn in 16 days and can be followed all the way around once you know what to look for.

This month Saturn increases from 769 to 806 million miles from Earth. The apparent width of the rings consequently decreases from 45 seconds of arc to 43 seconds. Saturn is so far away that these relatively small changes in size and distance will not significantly alter the planet's appearance all winter.

Mars

Now about 15 times fainter than it was during its close approach to Earth last October, the red planet is simply a "star" in the western sky. Moving from Aries into Taurus in February, Mars will be between the Pleiades and the Hyades during the last few days of the month. At magnitude +1.0 at that time it will be virtually the same brightness and similar in color to nearby Aldebaran.

Mars will be back in the news shortly as four Soviet spacecraft encounter it this month or early in March. The planet's distance rapidly increases in February from 106 to 131 million miles. At the latter distance spacecraft communications require nearly 12 minutes, one way.

Any telescope over three inches aperture will show the tiny disk of our planetary neighbor, but surface detail is impossible to detect as the globe shrinks from 8.2 to 6.6 seconds of arc in apparent diameter during the month. But last autumn our readers were busy, as the drawings and photographs on these pages indicate.

Mercury

A fairly good opportunity to see the innermost planet presents itself around Feb. 9 when it will be low in the west shortly after sunset; the observing period spans the first two weeks. Mercury's magnitude drops from -0.8 to +0.8 during that time as its phase decreases from 80 percent illumination (5.9 seconds of arc in diameter) to 25 percent on the 15th (8.5 seconds diameter). The phases are difficult to observe with telescopes under six inch aperture but they have been seen in three inch scopes.

Mercury cannot be mistaken — there are no bright stars or planets near it on this appearance. Just look to the west about 40 minutes after sunset; the clearer the horizon, the better.

Venus

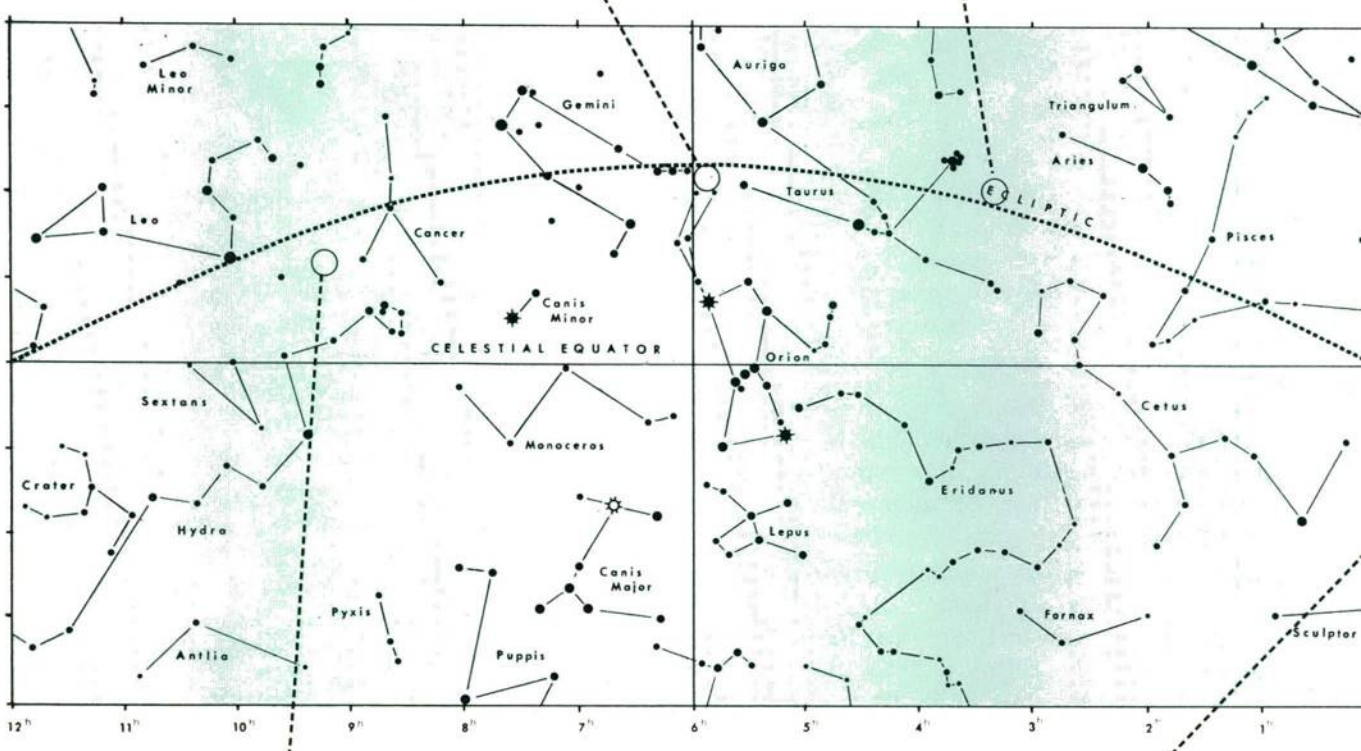
Now spectacularly brilliant in the early

MARS

February	1	15
R.A.	2^h53^m	3^h22^m
DEC.	+18°04'	+20°06'
DIST.	1.136A.U.	1.274A.U.
DIA.	8.2"	7.3"
MAG.	+0.5	+0.8

SATURN

February	1	15
R.A.	5^h53^m	5^h51^m
DEC.	+22°28'	+22°31'
DIST.	8.273A.U.	8.452A.U.
DIA.	18"	18"
MAG.	0.0	+0.1



FULL MOON

February 6

R.A.	9^h15^m
DEC.	+11°50'

MERCURY

February	1	15
R.A.	21^h58^m	22^h49^m
DEC.	-13°31'	-5°06'
DIST.	1.165A.U.	0.7963A.U.
DIA.	5.7"	8.4"
MAG.	-0.8	+1.0

This planet finder chart shows the positions of the sun, moon, planets and brighter asteroids for the current month as they appear against the background of the zodiac. Positions are plotted for the 15th with additional ephemerides for the 1st. To find zodiacal constellations visible during the current month, see Star Dome.

JUPITER

February	1	15
R.A.	21^h37^m	21^h50^m
DEC.	-15°02'	-13°57'
DIST.	6.004A.U.	6.020A.U.
DIA.	30"	30"
MAG.	-1.5	-1.5

PALLAS

February	1	15
R.A.	18^h46^m	19^h04^m
DEC.	+4°46'	+5°49'
DIST.	3.979A.U.	3.903A.U.
MAG.	10.1	10.1

URANUS

February	1	15
R.A.	13^h44^m	13^h44^m
DEC.	-10°08'	-10°06'
DIST.	18.16A.U.	17.93A.U.
DIA.	3.7"	3.8"
MAG.	5.7	5.7

JUNO

February	1	15
R.A.	19^h53^m	20^h15^m
DEC.	-12°30'	-11°30'
DIST.	3.849A.U.	3.759A.U.
MAG.	10.8	10.8

NEPTUNE

February	1	15
R.A.	16^h31^m	16^h32^m
DEC.	-20°17'	-20°18'
DIST.	30.74A.U.	30.53A.U.
DIA.	2.3"	2.4"
MAG.	7.7	7.7

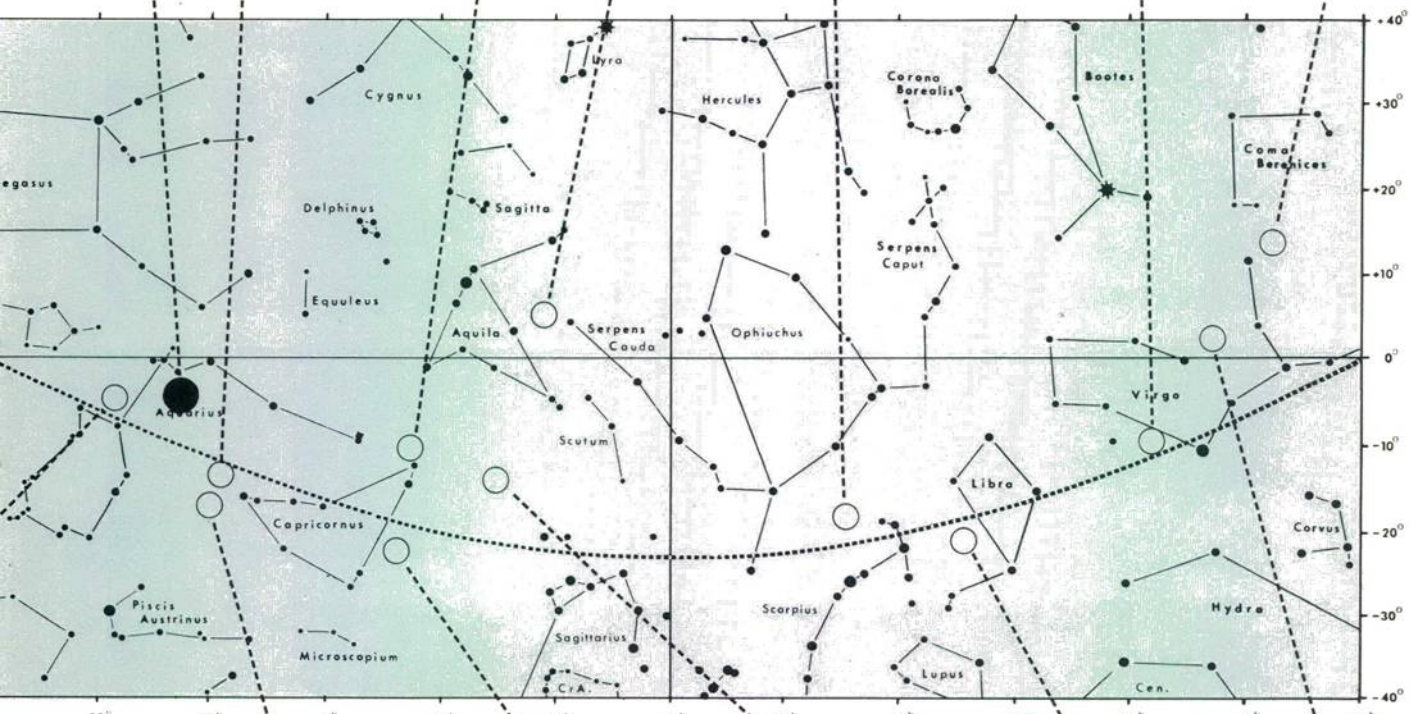
PLUTO

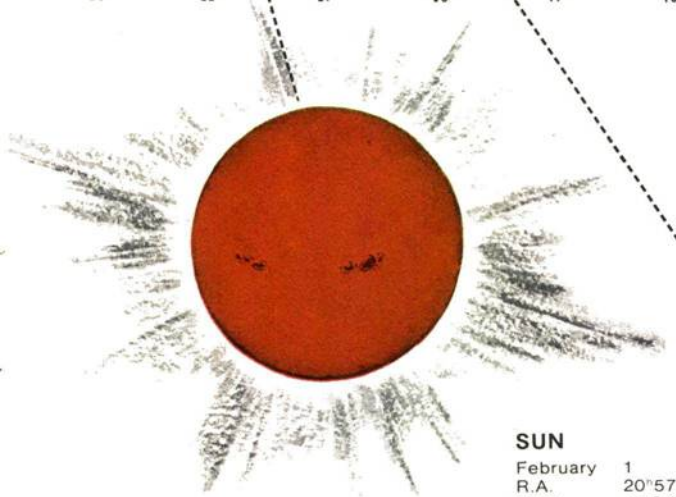
February	1	15
R.A.	12^h50^m	12^h49^m
DEC.	+13°00'	+13°09'
DIST.	30.40A.U.	30.21A.U.
MAG.	14	14

NEW MOON

February 22

R.A.	22^h13^m
DEC.	-6°07'





VENUS

February	1	15
R.A.	19^h58^m	19^h46^m
DEC.	-12°57'	-13°54'
DIST.	0.2799A.U.	0.3375A.U.
DIA.	1.0'	49"
MAG.	-3.7	-4.3

VESTA

February	1	15
R.A.	13^h13^m	13^h18^m
DEC.	+2°02'	+2°41'
DIST.	1.711A.U.	1.552A.U.
MAG.	6.4	6.4

THIRD QUARTER

February 14

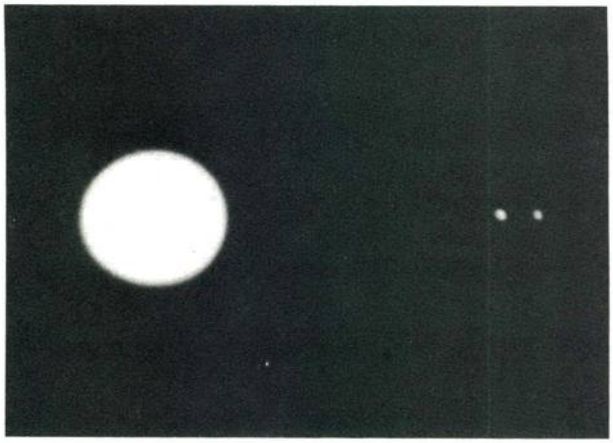
R.A.	15^h27^m
DEC.	-21°37'

CERES

February	1	15
R.A.	20^h20^m	20^h44^m
DEC.	-24°37'	-23°37'
DIST.	3.905A.U.	3.864A.U.
MAG.	8.7	8.7

SUN

February	1	15
R.A.	20^h57^m	21^h53^m
DEC.	-17°16'	-12°53'
DIST.	0.9853A.U.	0.9877A.U.
DIA.	32'	32'



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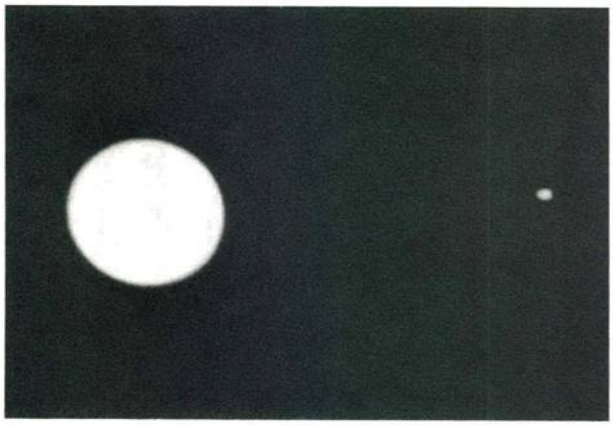

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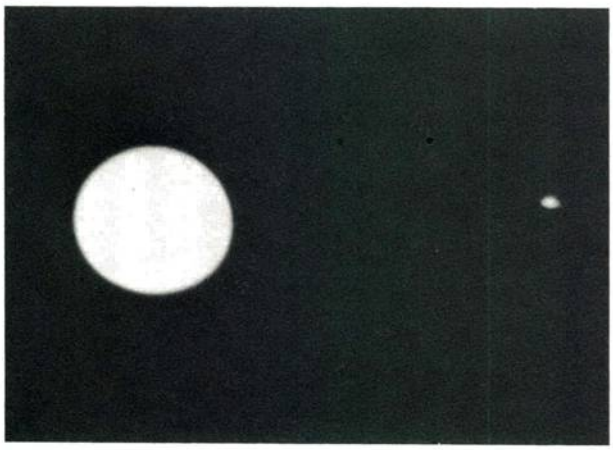

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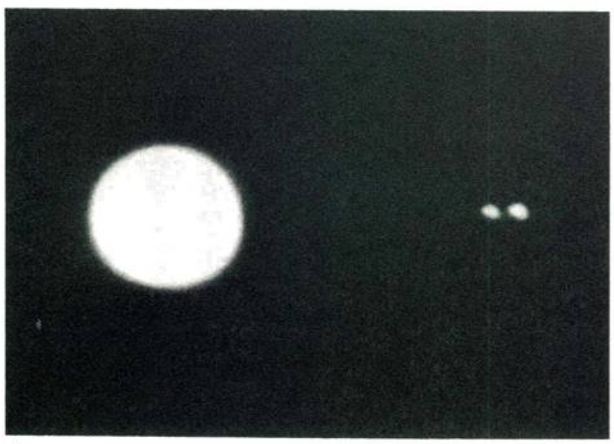

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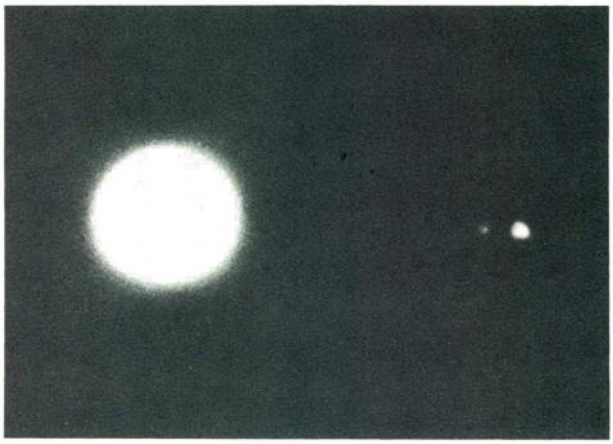

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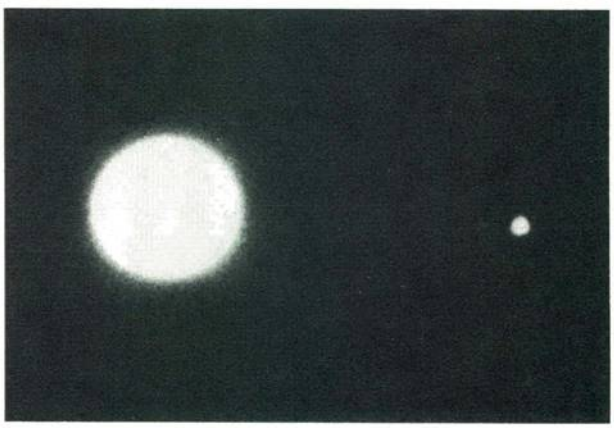

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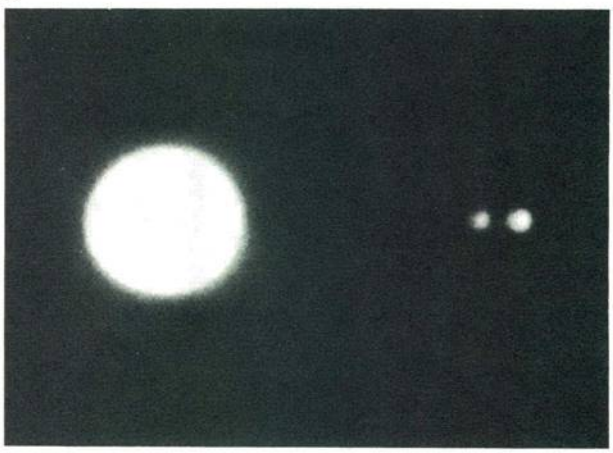

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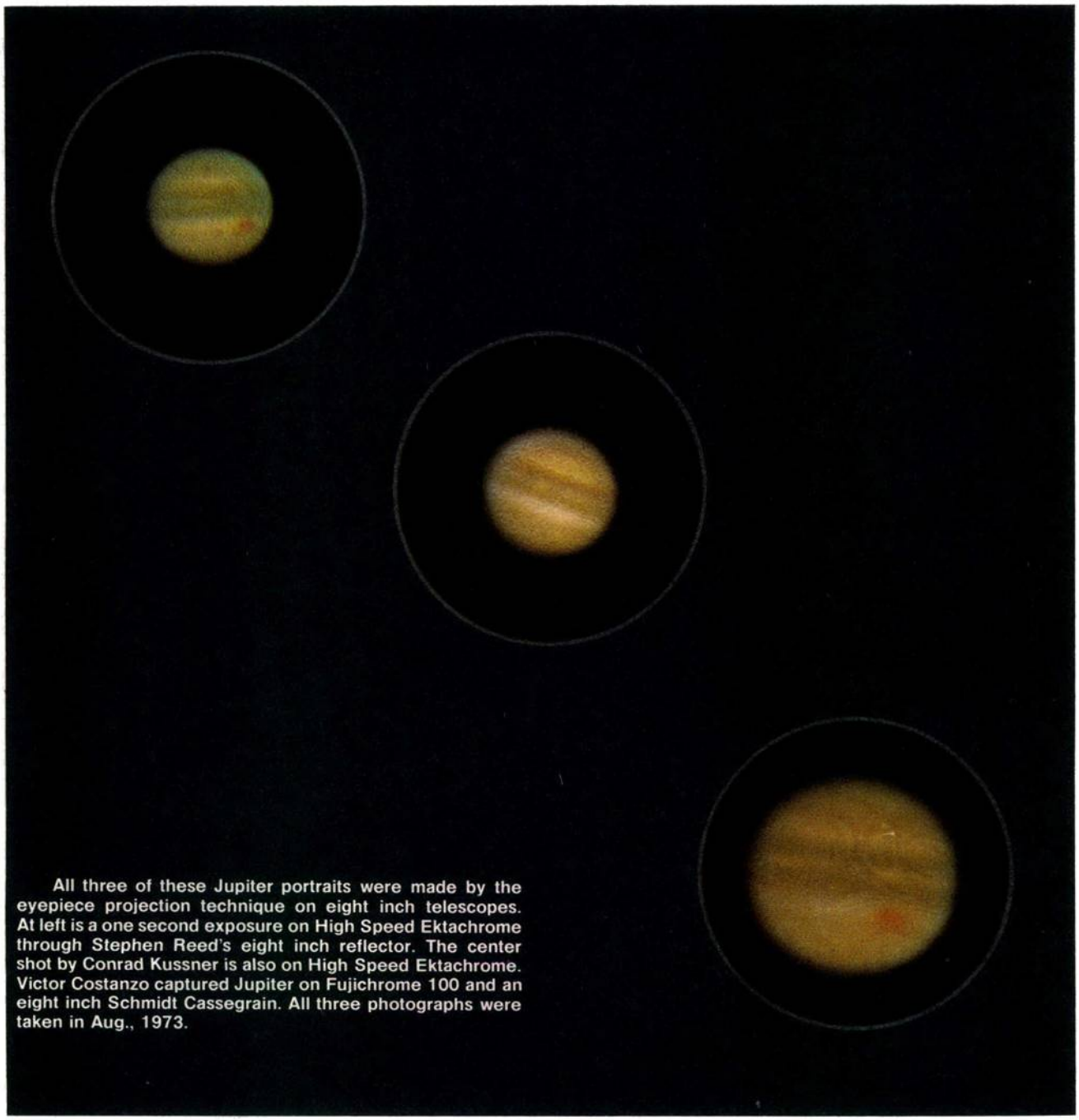
Photographs by Mike Otis

On the morning of Sept. 24, 1973, astronomy — photography enthusiast Mike Otis of Aberdeen, S.D. captured this remarkable series of photos of Jupiter and its moons Ganymede and Europa. At 1:08 a.m. EDT (photo 1) Otis captured Jupiter (the overexposed globe in all these photos) with Ganymede — nearest Jupiter — and Europa. Both moons were heading west (moving away from Jupiter) but Europa slowed down as it neared the western side of its orbit. This allowed Ganymede to overtake Europa and pass directly in front of it at 2:02 a.m. as seen in the second photo. The two moons appeared as an egg-shaped object two minutes later in photo 3 and were completely separated at 2:36 a.m. in photo 4. Although such occultations are rare an even more infrequent event began at 2:52 a.m. (photo 5). The shadow of Ganymede was sweeping over Europa and by 2:53 the smaller moon had dropped five magnitudes and was barely detectable (photo 6). By 2:55 a.m. all was normal again. Eclipses such as this are very rare — no more are due until 1979. For this series of photographs Otis used eyepiece projection on his eight inch Newtonian telescope. Exposures on Tri-X film ranged from 2 to 3-1/2 seconds.



All three of these Jupiter portraits were made by the eyepiece projection technique on eight inch telescopes. At left is a one second exposure on High Speed Ektachrome through Stephen Reed's eight inch reflector. The center shot by Conrad Kussner is also on High Speed Ektachrome. Victor Costanzo captured Jupiter on Fujichrome 100 and an eight inch Schmidt Cassegrain. All three photographs were taken in Aug., 1973.

morning, Venus greets those who, by choice or necessity, are up and outside more than 1/2 hour before sunrise. This brightest of all planets will best be seen toward the end of February in eastern pre-dawn skies.

At month's end any small telescope will show the 40 second of arc diameter, 27 percent illuminated crescent of Venus. As the planet swings toward the far side of its orbit in the next few months, the brilliant white globe will shrink in diameter and increase in phase.

Jupiter

The sun is very nearly between Earth and Jupiter so for us the planet is unobservable this month. Six months ago many astronomy enthusiasts were enjoying viewing the multicolored world. Telescopes, large and small, were pointed to catch the light from the giant planet nearly half a billion miles away. Some of the results of this scrutiny are displayed on these pages.

In a letter to the editor (in the November issue of ASTRONOMY) Thomas C. Bretl discussed visibility of the shadows of the four major Jovian moons. Noting the differing sizes of the shadows, it should be easier to see those cast by Io and Ganymede, with Europa and especially

The last few minutes of Mercury's transit of the sun was recorded in these 1/50 second exposures on Plus X film by Ronald Parmentier of Green Bay, Wisc. The inky black dot forming the innermost planet's silhouette will not be seen crossing the sun again (from the United States) before 2003.

Callisto more difficult to see.

Bretl further wondered if Callisto's shadow would be visible at all in a three inch telescope. Well the editors wondered too since our observing records did not show a shadow transit observation made with a three inch or smaller instrument.

On Aug. 23, 1973 at 12:24 a.m. EDT Alan Pattee of Williamsville, N.Y. observed the shadow of Callisto on Jupiter with a 2.4 inch refractor with magnification up to 120. According to Pattee, "the shadow was rather difficult to see; averted vision increased visibility."

The following night under conditions of "relatively poor seeing" Pattee observed Io's shadow and found it to be "easier to see than Callisto's". So it seems that, although difficult, the shadows of all of Jupiter's moons are visible to reasonably experienced observers using quite small telescopes in good seeing.

Castor

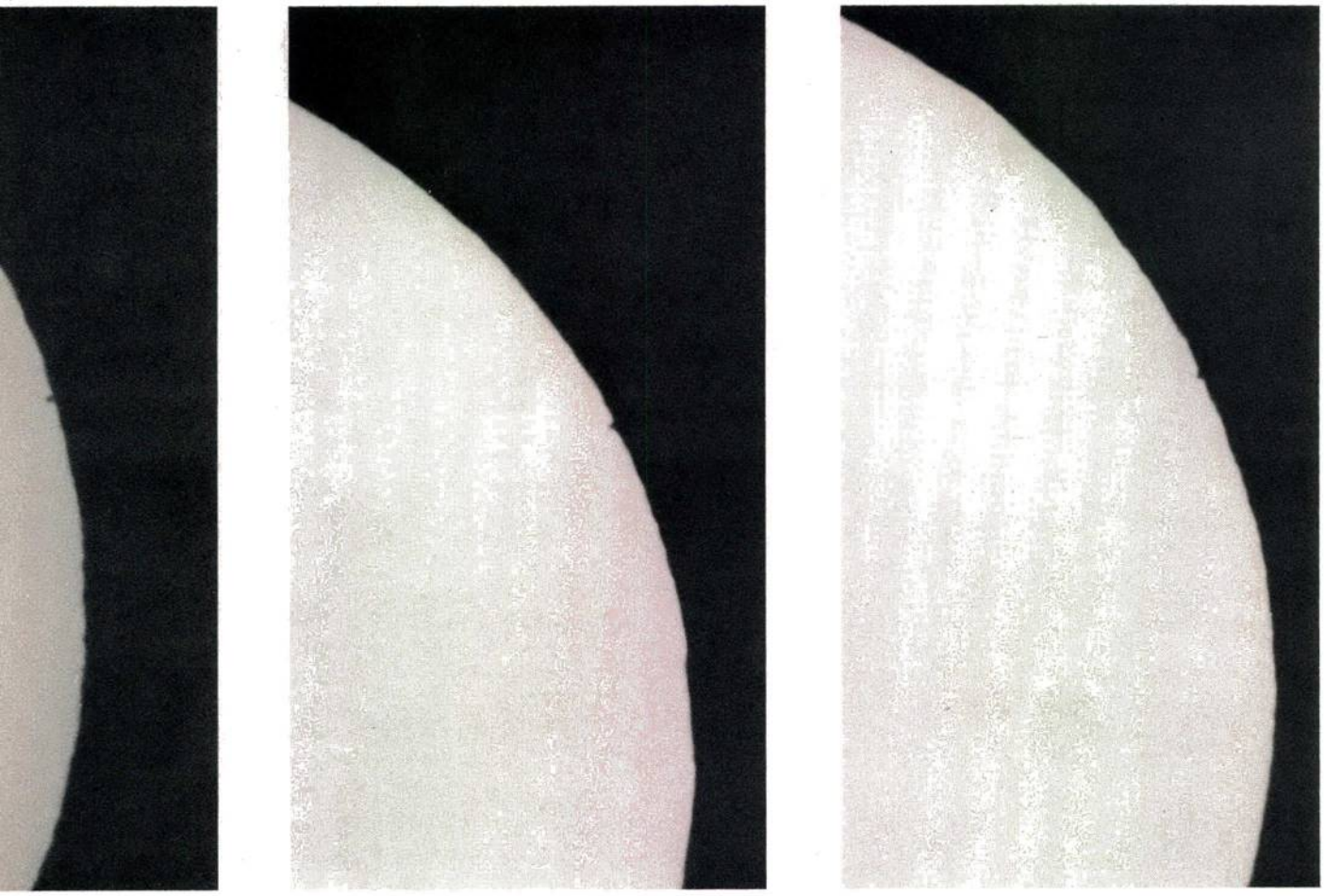
One of the twin bright stars of Gemini is far more interesting than the naked eye view would suggest. Historically this was the first binary star system to be recognized — that is, the first object outside the solar system where the laws of gravity were obviously controlling events.

The two stars that are seen in three inch or larger telescopes are magnitude 2.0 and 2.8. They are only 1.9 seconds of arc apart so look for the two stars to seem to be almost touching each other.

Each of these two stars is itself a double, detectable only by spectroscope. All four stars are hot white suns slightly larger and brighter than our own.

The visible binary system has an orbital period of about 400 years. We have just passed minimum separation; the distance is now increasing and will reach about six seconds of arc by the year 2050. The real separation involved is 8.4 billion miles — over twice Pluto's distance from the sun.

An additional member of the system, known as Castor C, is a faint ninth magnitude star 72



seconds away from the others. Amazingly it too is a double consisting of two red dwarf stars about 1/40 as bright as the sun.

So once again, the eye sees only a pinpoint of light, the telescope reveals two, and the spectroscope, six: a spectacular celestial waltz orchestrated by the laws of gravity!

Star Gallery '74 Technical Data

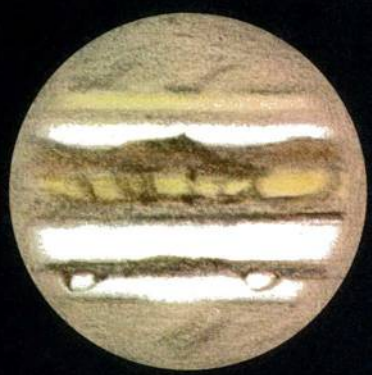
John Harmon photographed the transit of Mercury from Milwaukee, Wisc. This series represents the last 10 minutes of the event. He used 1/4 second exposures on Kodak Photo Micrographic film, and a Chromium Solar filter of his own design on a four inch f/15 Unitron refractor telescope.

Conrad L. Kussner recorded the end of the transit near Birmingham, Ala. He used an eight inch Celestron telescope and 1/30 of a second exposure through a three inch off axis sun filter.

Tim Kilby, Alexandria, Va., made photographs of the transit using two techniques. Both photographs were made with a 400mm telephoto lens and 3x teleconverter (1200mm E.F.L.). The bluish photograph on the left page started as a black and white high contrast copy film negative processed in D-19. The exposure was 1/30 of a second at f/32 using a 3.0 neutral density gelatin filter. The negative was printed on black and white paper and then copied on color duplicating film through a blue gelatin filter. The photograph on the right page was shot on Kodak Photo Micrographic film for an exposure of 1/250 of a second.

Ronald D. Rotunda photographed the transit from Springfield, Va. He used an eight inch Celestron telescope and a Minolta SRT-101 camera for his end of transit series.

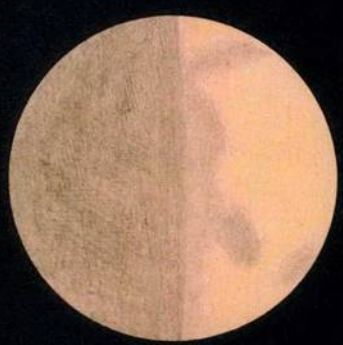
For this month only, Gazer's Gazette will not appear due to an expansion of Sky Almanac to include some of the large number of photos and drawings received from our readers over the past few months.



Jupiter, July 29, 1973, 11:40 p.m. EDT. 10 inch Newtonian reflector, 152 to 216x; seeing 5; transparency very good.

Jupiter, Aug. 2, 1973, 11:23 p.m. EDT. 10 inch Newtonian reflector, 152 to 216x; seeing 6; transparency fair.

Mercury, June 2, 1973, 9:00 p.m. EDT. 5 inch Schmidt Cassegrain, 250x, 23A filter; seeing very poor — size and shape of dark areas questionable; transparency good.



Mercury, June 15, 1973, 9:00 p.m. EDT. 5 inch Schmidt Cassegrain, 185 to 370x, 23A filter; seeing good, image fairly steady; transparency good.

Mercury, June 25, 1973, 9:10 p.m. EDT. 5 inch Schmidt Cassegrain, 185 to 250x, no filter; seeing fair; transparency fair.

Mars, Sept. 9, 1973, 11:45 p.m. EDT. 5 inch Schmidt Cassegrain, 180 to 250x; seeing 3; south polar cap evident; transparency excellent. The triangular dark area at center is Syrtis Major. C.M. = 270 degrees.

Mars, Sept. 19, 1973, 12:30 a.m. EDT. 10 inch Newtonian, 216x, 23A filter; seeing variable 2 to 5; transparency excellent. C.M. = 195 degrees.

Mars, Sept. 12, 1973, 11:55 p.m. EDT. 10 inch Newtonian, 216x; seeing 3; transparency excellent. C.M. = 245 degrees.

Mars, Oct. 8, 1973, 11:50 p.m. EDT. 10 inch Newtonian, 216 to 305x; seeing variable 4 to 7, surface markings intense and clearly seen with south polar cap very bright; transparency fair. C.M. = 15 degrees.

Mars, Sept. 15, 1973, 12:20 a.m. EDT. 5 inch Schmidt Cassegrain, 186 to 250x; seeing 4; transparency fair. C.M. = 235 degrees.

Mars, Oct. 9, 1973, 11:40 p.m. EDT. 10 inch Newtonian, 216 to 305x; seeing variable 4 to 6; transparency fair. Margaritifer and Meridiani Sinus are near center. C.M. = 10 degrees.

Notes: Seeing, when numerically rated, is on a 0 to 10 scale with 10 indicating a steady sharp image and 0 indicating a hopelessly blurred image due to atmospheric turbulence. Transparency refers to the clarity or lack of haze in Earth's atmosphere at the time of observation. Carlino marked off bright or dusty zones on Mars and bright areas on Mercury with a dashed line. Drawings have been oriented with north at top. C.M. in the Mars drawings means central meridian and refers to the Martian longitude at the center of the disk.

Drawings by Lawrence M. Carlino

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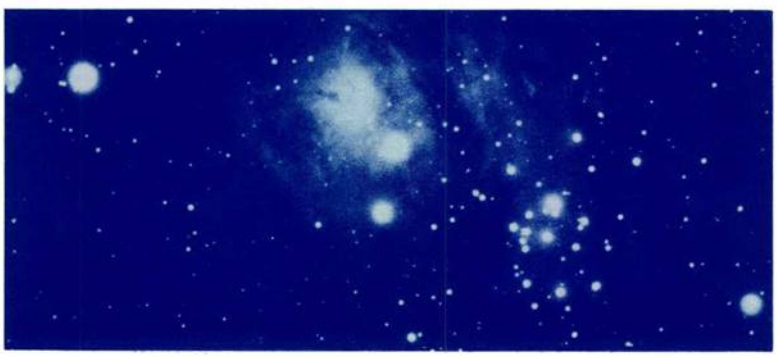

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ASTRO-NEWS

Latest News From the World of Astronomy

New Solar Cycle Observed

The first evidence that a new 11 year cycle of solar activity has begun was announced in December by a team of astronomers at Kitt Peak National Observatory in Arizona. Observations with the observatory's McMath solar telescope late in Aug., 1973 revealed an active region at high latitudes on the solar disk with magnetic polarity opposite to that of active regions during the present cycle. This and two other types of magnetic evidence mark the onset of the new cycle.

While no fully accepted explanation yet exists for the solar cycle itself — the gradual rise and fall in the level of sunspot and solar flare activity over approximately an 11 year period — many details of the emergence and evolution of these cycles are known. These include the change in magnetic polarity of active regions as new-cycle activity begins. This normally follows by a year or more a change in the polarity of the general magnetic fields that are observed near the sun's north and south polar regions. (Astronomers have developed techniques for detecting the magnetic polarity of a sunspot.)

New-cycle activity also usually begins a year or so before the minimum level of sunspot and flare activity associated with the previous cycle is reached. In general, old-cycle activity moves toward the solar equator and dies out, while new-cycle activity begins at high latitudes. Thus, there is an overlap in time but not in position of the activity associated with old and new cycles.

The solar cycle now ending, which is expected to reach its minimum during 1975, is the 20th since these observations were first systematically recorded by astronomers in 1755. The new cycle, number 21, is expected to reach maximum activity around 1980. The previous solar minimum during 1964 and 1965 was the occasion for a coordinated 18 month program of observations of the sun and its effects on Earth by the world's scientists, during a period known as the International Years of the Quiet Sun.

Many of the sun's effects on Earth can best be studied during such a period of solar-terrestrial calm, when it is possible for scientists to relate the effect of a single, isolated solar event to specific changes in Earth's magnetic field and upper atmosphere. During maximum solar activity, periodic interruptions of radio communications take place, caused by bombardment of Earth's magnetosphere, or magnetic

continued on page 49

LUNAR PEEK-A-BOO

NASA Photograph

Enroute to Venus and Mercury, Mariner 10 took this picture of the northeastern part of the moon on Nov. 3. The dark area near the center of the picture is Mare Humboldtianum (about 125 miles in diameter) in the densely cratered highlands. The bright streaks are crater rays. This picture was taken at a distance of about 70,000 miles. Mariner 10 will take Mercury photos from as close as 3,300 miles on March 29.

Life Molecules Detected In Space

Peering into the darkness between the stars, radio astronomers have discovered what is apparently the initial state in the evolution of stars, planets and, ultimately, of life. Recent discoveries bring to 23 the number of molecules that have been detected in the far reaches of the Milky Way. Many are the precursors to life — at least in the chemistry that we understand.

It was long thought that these "organic" compounds could be produced only by living organisms. But in the last few decades they have been synthesized in the laboratory.

According to Dr. Philip M. Solomon of the University of Minnesota, "the question of how far chemical evolution in the interstellar medium proceeded toward biochemistry is not yet answered, but it has clearly gone further than anyone would have estimated five years ago."

In a recent issue of Science Dr. Edward Anders and Dr. R. Hayatsu at the University of Chicago and Dr. Martin Snider of the Argonne National Laboratory say that intermediate substances, or catalysts facilitate the assemblage of complex molecules. This hypothesis has been advanced to account for the extraordinary variety of organic substances found in certain meteorites, known as carbonacious chondrites. For example, fatty acids built on from 12 to 20 carbon atoms have been found in seven such meteorites.

Examination of these recently fallen meteorites has produced amino acids (from which proteins are constructed), as well as purines and pyrimidines, substances of the type that form such key chemicals of life as DNA (deoxyribonucleic acid). Of 61 different kinds of hydrocarbons in the Murchison meteorite (one of the best studied samples), 42 have been synthesized by the methods the scientists suggest.

It is proposed that in the formative stage of the solar system such substances as magnetite and hydrated silicates served as the catalysts. The process is proposed as an alternate to the one suggested in the 1950s by Dr. Harold C. Urey and demonstrated by Dr. Stanley L. Miller. It consisted of a straightforward "organic" synthesis using four gaseous starting substances — water, methane, ammonia and hydrogen — under stimulation by an energy source, such as electric sparks.

Among the telltale radio emissions detected from far out in the galaxy by radio astronomers are those of formaldehyde (precursor to the sugars), hydrocyanic acid (which can develop into the purines) and cyanoacetylene (precursor to the pyramidines). Thus, even in distant space, there is a start toward the evolution of DNA.

The chemistry that is being observed with radio telescopes is unfamiliar to earthbound scientists, for it occurs under circumstances utterly remote from those that can be achieved in the laboratory. Both pressure and temperature are extremely low — the pressure being that of an almost total vacuum.

Formation of the observed molecules cannot depend on random collisions between atoms, according to those who have analyzed the likelihood of such encounters. Even the entire age of the universe would not provide enough time to account for synthesis of the material in this manner.

Hence we have speculation that the molecular synthesis uses a catalyst — the required agent being the interstellar dust grains that could collect atoms and enable them to fuse.

Meanwhile a new millimeter wavelength radio telescope — the type used for most space molecule discoveries so far — will be going into operation at Kitt Peak in a few weeks. It will be 250 times more sensitive than its predecessors and should add many new molecules to the 23 now logged.

The fact that the long accepted Miller-Urey hypothesis is being shaken by these discoveries could have some far reaching effects on man's concept of how life, and ultimately man, got started.

Employment Picture For Astronomers Bleak

Of the 130 Ph.D. astronomers produced by our nation's universities each year, almost half are unable to find jobs in their chosen field. These young astronomers are either unemployed or working in fields for which they were not trained.

In his recent address to the American Astronomical Society in Tucson, Ariz., Dr. Bart J. Bok, president of the AAS, told of the plight of young astronomers. He said that more astronomers are being produced each year and the trend is not being reversed as increasing numbers of students are entering universities intending to graduate as astronomers. Bok suggested a reversal in this cycle even though it may jeopardize the position of some astronomy professors.

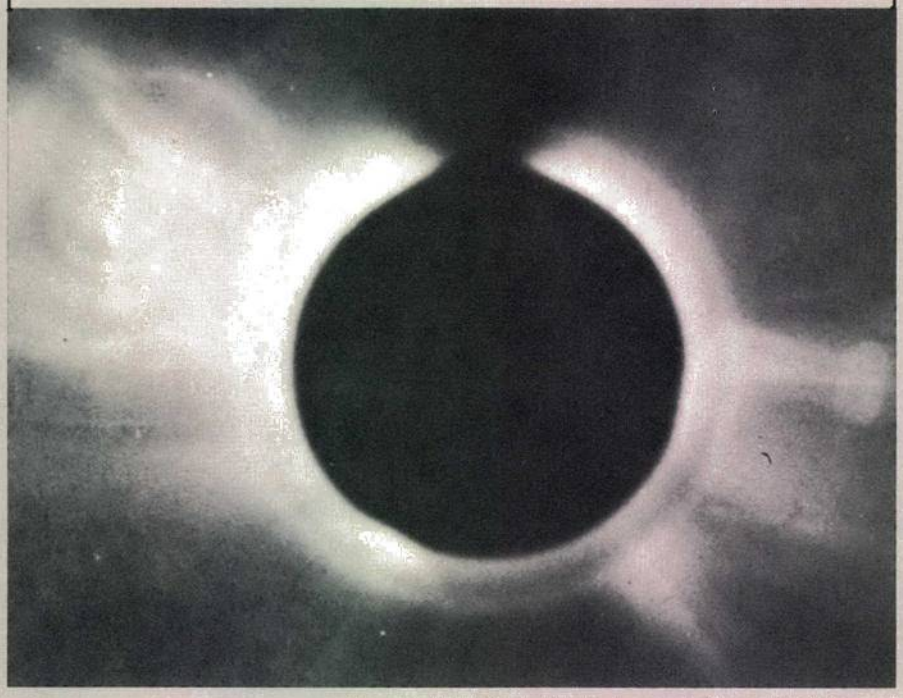
Bok indicated it was unfair to enroll and encourage astronomy students when the existing situation means that many of them will find it very difficult or impossible to obtain a position in the field. He quoted a letter from a recent graduate astronomer who had to look elsewhere for employment.

"If an astronomy department cannot place its Ph.D's it should not produce them. I really see no good news in the future. I remain convinced that the main problem is to convince the astronomy establishment that there is a problem and that the main source is overproduction. Unfortunately I am equally convinced that there is no more comprehension of this fact now then there was two years ago."

Bok said this student epitomized the plight of many and that there were likely to be even more in this situation because 100 more students have been admitted into astronomy programs this year than last.

A cut in enrollment of 30 percent was suggested by Bok to reduce the number of graduating astronomers to a level where they could be absorbed into the job market. He reported that at present, we are still in the grim period in which up to 100 qualified applicants present themselves for every postdoctoral and faculty opening that becomes available in the field of astronomy.

PROMINENT PROMINENCE



National Center for Atmospheric Research Photograph

A spectacular eruptive prominence, seen to the left in this Skylab photo, extends out more than two solar diameters from the surface of the sun. Unobstructed by Earth's atmosphere, the Skylab coronagraph artifically blocks the sun (black disk) enabling us to see greater detail than ever before recorded in the corona. The loop structures in the prominence are caused by the sun's magnetic lines of force. The process by which this solar material is ejected, at one million miles per hour, is not yet understood. The photo was taken by the Skylab astronauts on June 10, 1973.

Solar Cycle And Earth Weather Linked

Two scientists have independently shown evidence that activity on the sun changes weather on Earth.

Professor John Wilcox of Stanford University found that when a change in solar magnetic patterns moves past Earth, usually resulting from a solar flare, the average low pressure area at 30,000 feet altitude tends to decrease its pressure and later returns to normal. Low pressure regions are associated with storms and Wilcox said on the average, northern hemisphere weather is something like 10 percent better than normal a day or so after a change in the solar magnetic pattern passes by Earth.

Since the effect can be predicted by watching activity on the face of the sun this might turn out to be useful in weather forecasting.

The other relationship between solar activity and earthly weather comes from Dr. J. W. King of the radio and space research station at Slough, England. King suggested in a recent article in **Nature** that the connection between the solar cycle and the weather is not as appreciated as it should be. He gave numerous examples to show that the weather is better at the maximum and minimum of the 11 year sunspot cycle than it is at the intermediate periods. Right now we are at the minimum of the current solar cycle.

King said the variations are caused by low pressure areas between latitudes 75 and 79 degrees north which are affected by incoming high energy solar particles channeled to these latitudes by Earth's magnetic field. He suggested that a fuller understanding of the relationship between the weather and the 11 year solar cycle may make decade-long weather forecasting a possibility.

Cycle Observed

continued from page 47.

envelope, by clouds of charged particles and associated magnetic fields that move explosively outward from the sun through the inner solar system.

Kitt Peak astronomers observed the first sunspot of the new cycle, one having a positive magnetic polarity, on Aug. 22, 1973, at a latitude of 45 degrees south. By Aug. 27, this new region of activity had disappeared but its characteristics had been recorded on magnetograms made with the McMath telescope. A second indication of the onset of the new cycle has come from research now in progress on more quickly changing areas of magnetic activity — those lasting only about one day and not associated with sunspots. Studies from May through July last year of 560 of these "ephemeral" active regions show that magnetic polarities corresponding to the new cycle dominate at higher latitudes, especially in the south.

Current models of the solar cycle predict that magnetic fields at the poles of the sun are supposed to reverse polarity once each cycle before the beginning of the next cycle. For the current cycle, such a reversal took place in mid-1971 at the north pole and about a year later at the south pole.

It is not certain, however, that polar magnetic fields maintain dominant polarities according to a schedule synchronized with the phase of the solar cycle. This is because fields at the poles, like those elsewhere on the sun, are concentrated into tiny elements which are hard to resolve with present equipment. A new Solar Vacuum telescope, now in operation on Kitt Peak, is designed to increase the resolving power for magnetic mapping of the sun from the present few seconds of arc to one second — equivalent to the size of a quarter at a distance of three miles, or an area 440 miles in diameter on the solar surface.

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Atmosphere Found on Ganymede

As a result of successful observations of Jupiter's fourth moon passing in front of an eighth magnitude star, astronomers have determined that the satellite is the largest in the solar system and is enshrouded in a detectable atmosphere.

The occultation took place on June 7, 1972 as Ganymede slowly passed in front of the star, an event observed only from India and Java. Instead of being winked out instantaneously the star gradually dimmed in brightness before being extinguished as the satellite passed in front of it. Earth's moon, in contrast, abruptly extinguishes any star it passes in front of due to our satellite's virtual absence of significant atmosphere.

The calculations that were necessary to evaluate the event required the better part of a year but the results are significant. The slow dimming of the star was definitely due to Ganymede's previously undetected atmosphere. The density of this atmosphere is somewhere between one thousandth and one millionth the density of Earth's atmosphere.

The nature of this newly detected atmosphere is open to speculation, which ASTRONOMY will report on in the months ahead. Future space vehicles that are capable of atmospheric analysis should settle the question. Pioneer 10 which recently passed by Jupiter will probably not shed any light on this new finding.

The diameter of Ganymede has been refined to 3,270 miles, slightly larger than was previously believed — definitely crowning Ganymede as the solar system's largest moon, larger than the planet Mercury.

American Science and Engineering Photograph

For the first time the solar corona — the tenuous faint outer atmosphere of the sun — has been seen over the entire face of our star. This breakthrough is one result of the Skylab mission whose cameras recorded the X-ray image seen here. The solar corona, consisting of a low density, highly ionized gas with a temperature of about two million degrees, until recently could only be observed as a bright halo during an eclipse. The visible light emitted from the corona is about one million times less intense than that of the underlying photosphere. The radiation emitted from the corona lies predominantly in the "soft" X-ray region of the spectrum, at shorter wavelengths than are emitted from all lower lying, cooler layers. Since Earth's atmosphere efficiently absorbs all soft X-ray radiation before it can reach Earth, such X-ray observations of the corona had to be made from sounding rockets and satellites until the advent of Skylab. At the start of the Skylab program nothing was known about the life cycle of bright points now found to be a distinct class of feature uniformly distributed over the entire disk. Other active regions are restricted to equatorial latitudes. A statistical analysis shows that the bright points have an average lifetime of eight hours. The dominance of the solar magnetic fields is clearly seen as the corona traces the lines of force. This soft X-ray image of the solar corona at the time of the June 30, 1973 eclipse was obtained by the X-ray telescope on Skylab, one of several photographic packages on the space station. The open region to the right of the picture, which is surrounded by apparently diverging quiet coronal formations, is called a coronal hole.

Soviets Report Strange Signals

Amid the rash of unidentified flying objects or UFO reports in Oct., 1973, the Soviet News Agency Tass reported detection of strange signals attributed to other intelligences.

The signals, received by four stations manned by Soviet radio astronomers and directed by astrophysicist Vsevolod Troitsky, seemed totally unlike any natural object in space. When the Soviet scientists asked if any American satellites were broadcasting the signals being received they were told "no". More recently however, the denial has been reversed and it is now acknowledged that an American satellite was indeed responsible for the baffling signals the Soviets have been studying.

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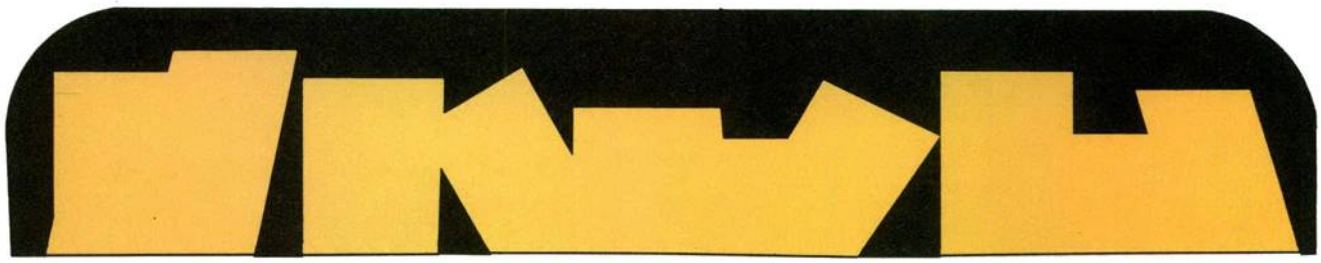

LETTERS TO THE EDITOR

Sir / I am a delighted new subscriber to your magazine. In particular, I am extremely pleased with the Photography in Astronomy department. I have been taking astrophotographs for a few years now, but have gotten more professional looking pictures due to your information.

CHRISTY H. BARNES
Stillwater, Ok.

Sir / Your magazine is great! Each issue seems to get better and better.

The art of Victor Costanzo is beautiful; it's a shame that copies are not available for your readers to purchase and display in their own homes.

RICHARD RICHTER
Ridgefield Park, N.J.

Sir / I would like to report some magnitude estimates of Comet Kohoutek made by members of the Hilltop Astronomy League: Nov. 10, 7.0; Nov. 20, 6.4; Nov. 29, 5.0; Nov. 30, 4.9; Dec. 1, 4.6; Dec. 2, 4.6, and Dec. 3, 4.3.

All estimates were made with binoculars by myself and three other observers. We estimated the tail of the comet at 1/2 degree on Nov. 20, increasing to about 1-1/2 degrees by Dec. 3. The comet was not a naked eye object (to us) before Dec. 2.

I would also like to take issue with the table of Saturn's satellites on page 50 of the December issue of ASTRONOMY. It states that the minimum aperture for detection of satellites Tethys and Dione is an eight inch telescope and a six inch telescope, respectively. However, I have picked up both satellites (in addition to Rhea, Titan, and Iapetus) in my 3-1/2 inch Questar. Most recently, I observed Tethys at 5 a.m. EST on Nov. 10, 1973.

BARRETT L. BRICK
New York, N.Y.

Mr. Brick / Thank you for your Kohoutek observations. Your sighting of five satellites of Saturn with a 3-1/2 inch aperture is quite remarkable. Over many years of telescope viewing we have never seen Tethys with less than a fine four inch refractor in excellent seeing. Usually it requires a six or eight inch scope.

Sir / I enjoy reading your magazine very much, especially the articles about the planets, the sun, the asteroids and comets and many more. I am in fifth grade, and we are learning about astronomy in school. My class likes your magazine a lot, too. The pictures are really great!

MICHELLE TARBESCU
West Hartford, Conn.

Sir / I've recently heard a theory which proposes to account for the mild autumn we've experienced and confirms the prediction of a mild winter.

The theory in question claims that the present climatic condition is caused by "sunspots" which further portend the coming of a 40 year cycle of draught.

Do you know of any such theory? Is there anything to it? Can spots on the sun actually cause such conditions on Earth? Are they merely symptoms which signal the presence of some other cause, or are they just coincidental?

CLIFFORD R. POSHADLO, JR.
Dearborn, Mich.

Mr. Poshadlo / We are unfamiliar with the particular theory you refer to, however some scientists are working on the relationship between weather and solar activity. See Astro-News this month for further details.

Sir / I have just read a letter to the editor by Neal Wilgus in the November issue of ASTRONOMY, suggesting that Planet X be named Janus. As I am sure other readers have by now pointed out, this is rather unlikely since the recently discovered tenth satellite of Saturn is already called Janus.

RONALD J. ADAMS
Tucson, Ariz.

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Frankly, we feel the photograph rivals the one made with the 200 inch Palomar telescope.

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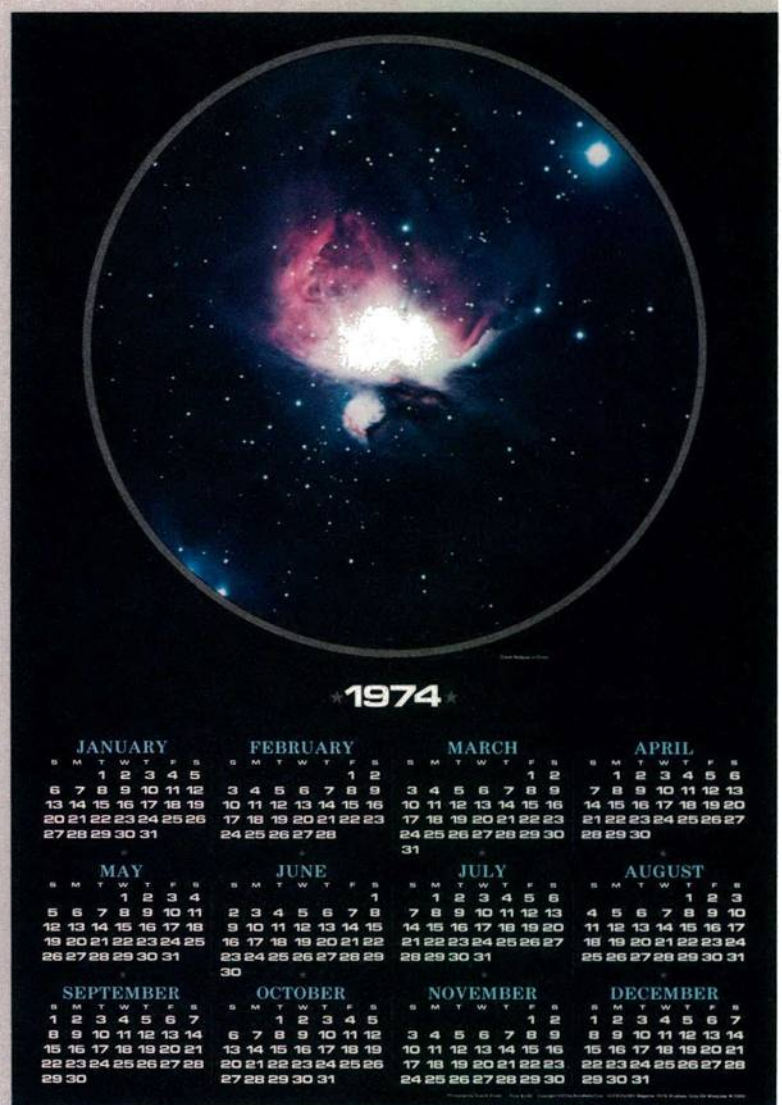

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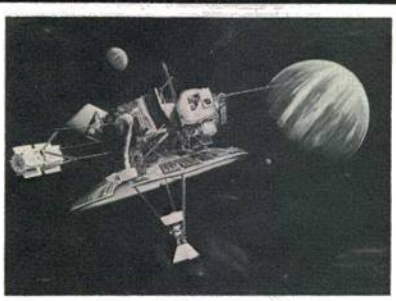
Pioneer 10
Jupiter Mission



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WANTED — Refractor for guide scope. 2-1/2" to 2-1/4". Contact Wayne Koskey, 906 S. 12th Ave., Wausau, WI 54401.

WANTED — Comments and recommendations by owners of Cave, Celestron, Criterion, Edmund, Questar, Star Liner and Unitron as to performance of their telescopes. Write Jim Marty, 8864 130th St. N., Hugo, MN 55038.

WANTED — Information (or reference to) on evidence of extraterrestrial influence upon early civilizations. If opinions are included, please indicate permission to use them. Write Kristi Kamerer, 6519 W. 87th Pl., Los Angeles, CA 90045.

WANTED — Norton's Star Atlas and/or Atlas Coeli of Antonin Becvar. Am also interested in opinions on the 6" RV-6 Dynascope regarding performance, clearness of objects, advantages, and disadvantages. Write John E. Hughes, 4 Marinello Ter., Albany, NY 12209.

WANTED — Star atlas, maps or charts for use in astronomy club. Also information on building an equatorial mounting and/or permanent observatory for a 10" telescope. Charles Vane, 713 Tulane Dr. N.E., Albuquerque, NM 87106.

WANTED — Criterion Manufacturing Co.'s declination slow motion control Catalog No. SMB-3 and Catalog No. KF-4 Flexline. Contact Tom Whitman, 285 Central Park West, New York City, NY 10024. Phone (212) 787-5226.

WANTED — Used Celestron 8" "like new" condition, or 4" refractor. Reasonable. Write Mike Petrozello, 1678 Selby Way, Williamson, NY 14589.

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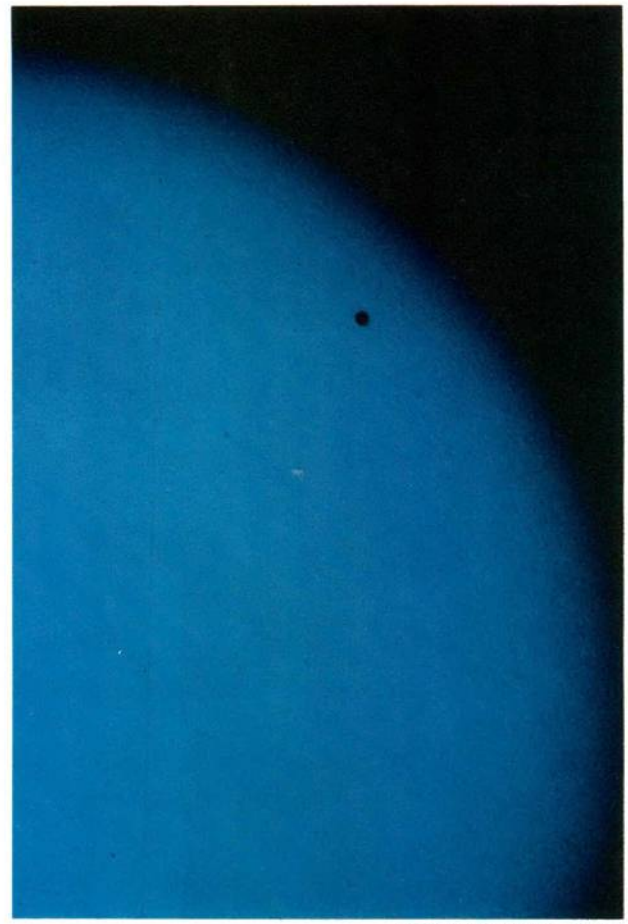
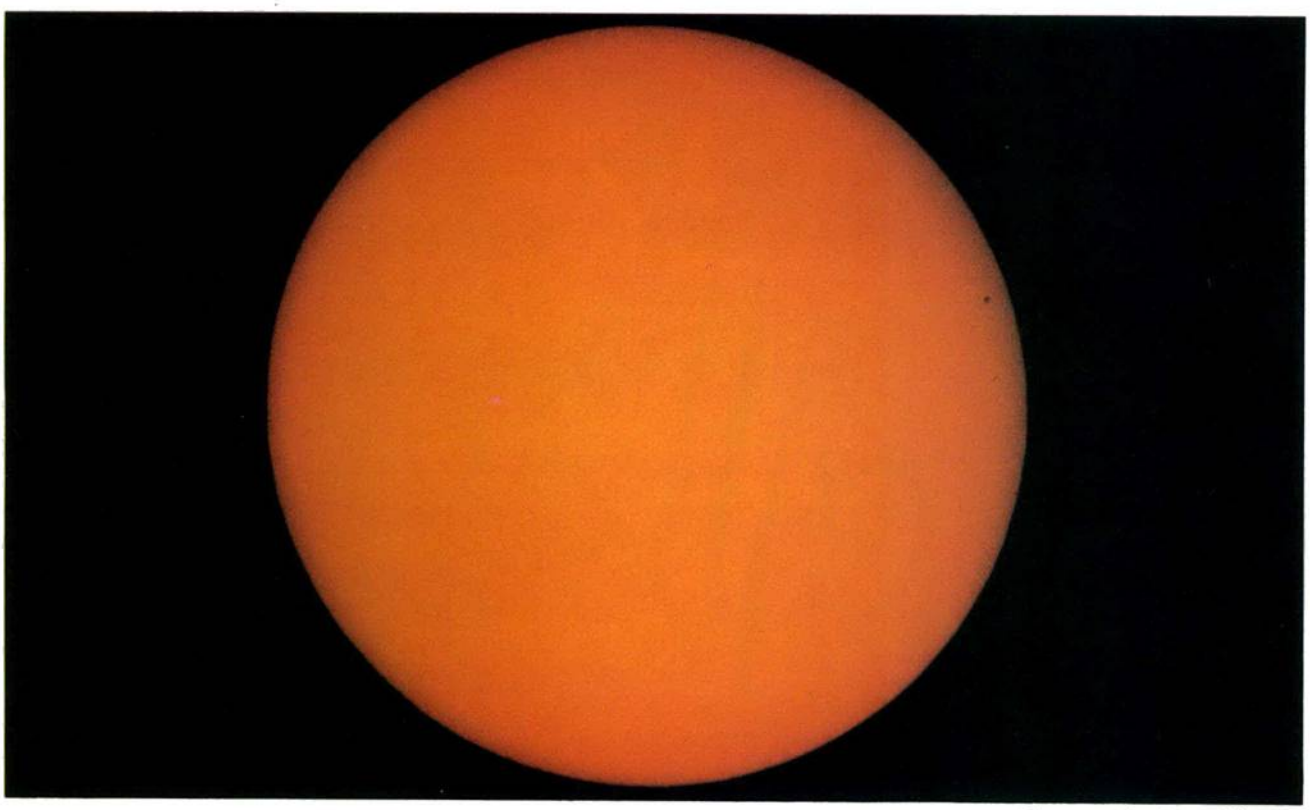


Photograph by Tim Kilby

STAR GALLERY

This occasional department is devoted to some of the best color astrophotographs we receive over a period of months. They are generally made by amateurs with easily available equipment. Payment for use of these photos is $10.00 each. For technical data on these photographs see page 43.



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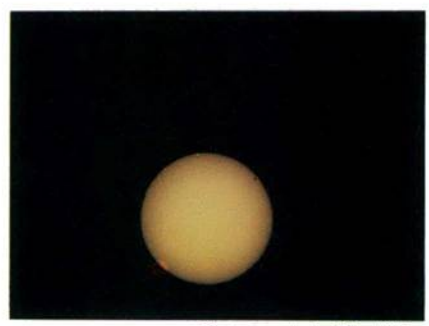

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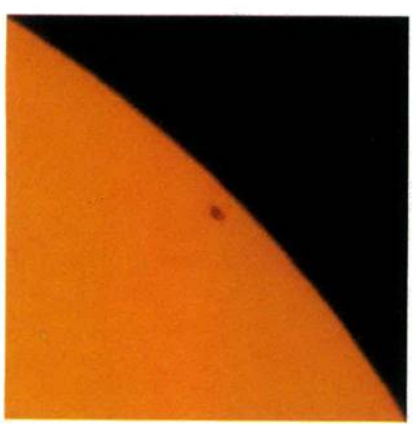
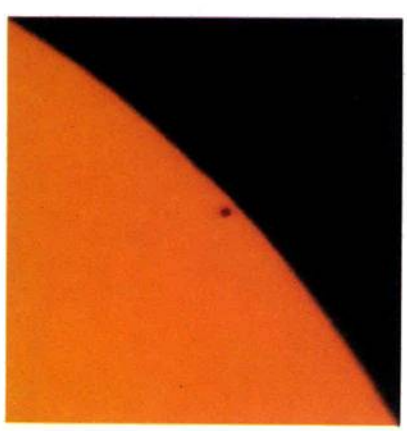




Photographs by Ronald Rotunda

Cancer

by
Thomas C. Bretl

Nestled quietly between Gemini and Leo, Cancer the Crab is the faintest of all zodiacal constellations, and one of little apparent interest. Having once marked the sun's position at the summer solstice, it does lend its name to the Tropic of Cancer, the northernmost parallel of latitude to receive the direct overhead rays of the sun; but today, even that distinction is largely undeserved. Precession has long since moved the summer solsticial point into Gemini, leaving Cancer with little obvious fame — and only five stars as bright as fourth magnitude!

Even to the naked eye observer, Cancer's

TABLE OF OBJECTS IN CANCER

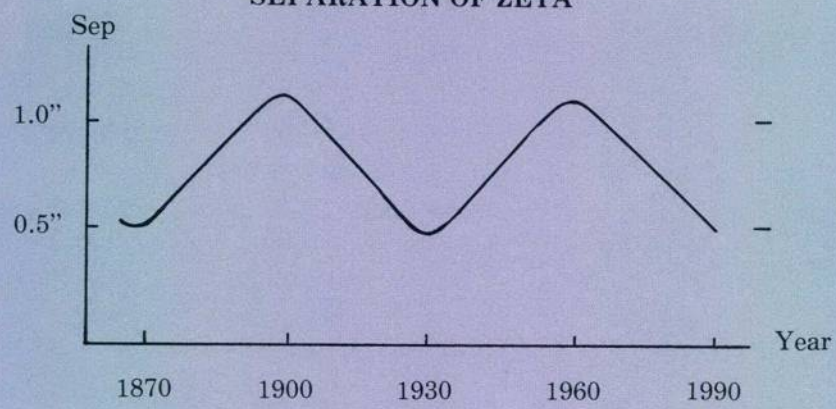
Clusters

Object	Mag.	Size	R.A.	Dec.
NGC-2632 (M-44)	6	90'	08^h38^m	+18°48' (the Praesepe)
NGC-2682 (M-67)	6	15'	08^h49^m	+11°55'

Double Stars

Object	Mag.	Separation	Color	R.A.	Dec.
ζ	5.1,5.7,6.0	1.0",6.0"	Yellow-orange	08^h10^m	+17°43'
ϕ^2	6.3,6.3	5.0"	White-white?	08^h26^m	+27°00'
6	4.2,6.6	30.7"	Yellow-blue	08^h45^m	+28°51'
57	5.9,6.4	1.5"	Yellow-yellow	08^h52^m	+30°41'
66	6.1,8.2	4.6"	White-blue	09^h00^m	+32°22'

SEPARATION OF ZETA



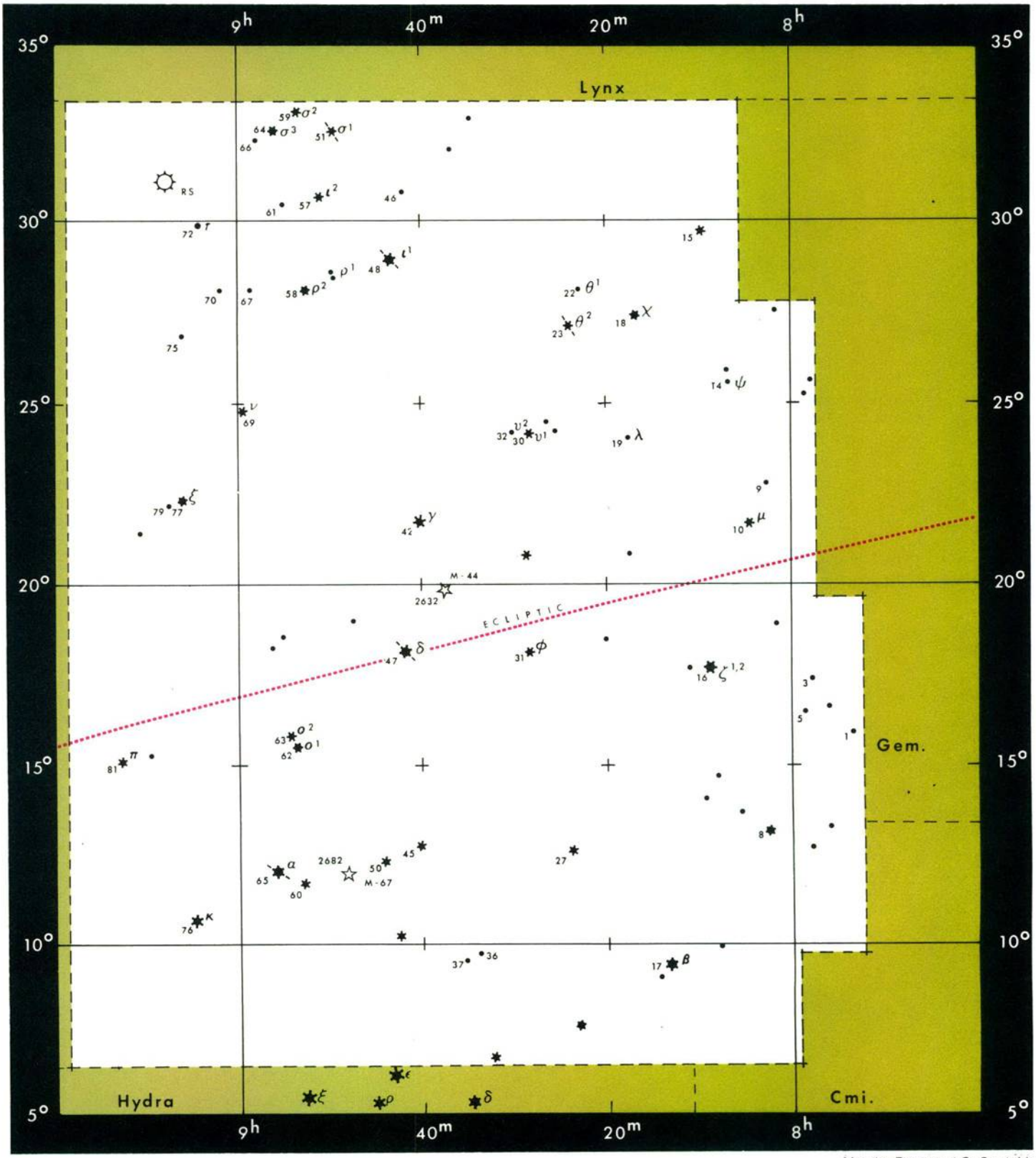
Zeta is a close binary with rapidly changing separation.

EPOCH 1970

most notable feature is not a star or pattern of stars, but rather a faint patch of light halfway between Delta and Gamma. Known since ancient times as the "Praesepe" (the Manger), this spot also attracted Galileo's attention over 300 years ago. When he turned his newly constructed telescope toward this fuzzy patch, it revealed its true nature as a remarkable galactic cluster. One can imagine Galileo's excitement when this "fuzzy patch" resolved itself into 36 individual stars.

The Praesepe is a very large (90 minutes of arc in diameter), loosely structured open star cluster which actually contains more than 60 stars brighter than tenth magnitude. Many of these form beautiful double and triple star combinations, and while most of them are white in color, several show a definite orange hue. These orange stars would probably go unnoticed elsewhere, but here they are in striking contrast with the countless white ones surrounding them.

Because of its extraordinary size, the Praesepe is likely to completely fill your telescopic



Map by Raymond G. Coutchie

Stellar Magnitudes	-1	0	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6 & fainter

Diffuse Nebula Double Stars Variable Stars ○

Galaxies Planetary Nebula ○ Open Star Clusters ☆ Globular Clusters ⊛

field of view. Low power, or even 7 x 50 binoculars, must be used to see it to best advantage. Then it is a truly magnificent sight — which more than compensates for Cancer's initial lackluster appearance!

Cancer's bad first impression is further overcome by several other interesting, beautiful objects. For example, two degrees west of Alpha Cancri is M-67, another open cluster near the threshold of naked eye visibility. With a diameter of approximately 20 minutes of arc, M-67 is much smaller than the Praesepe but is rich in stars, containing at least 200 (by Sir John Herschel's estimation) between 10th and 15th magnitude. It also has a rather curious shape. In a six inch telescope you see a semicircular grouping, surrounded on the round edge (after a slight gap) by another curved line of stars. The fainter stars brought out in a larger scope, of course, may change this pattern considerably.

For nebula hunters who prefer their fuzzy spots to remain unresolved, Cancer offers NGC-2775, a tenth magnitude galaxy in the extreme southern part of the constellation, a few degrees east of the head of Hydra. Appearing small, round, and featureless, NGC-2775 is nevertheless easily seen in a six or eight inch telescope. And although it is the only bright galaxy in the immediate vicinity, it foretells of the rich extragalactic hunting grounds now just rising in the east.

For those who prefer splitting double stars, on the other hand, Cancer offers some good tests and beautiful color contrasts. Iota Cancri, for instance, is "Cancer's Albireo". Though less brilliant than Albireo, Iota's separation and yellow-blue color combination are reminiscent of that famous double in Cygnus. Iota's colors are admittedly a bit more subtle, but they make for a striking and memorable sight. And as a test of your telescope's resolving power, try 57 or Zeta Cancri. With a separation of 1.5 seconds of arc, 57 should be within reach of a four inch telescope on nights of good seeing, while Zeta, whose separation varies between 0.5 and 1.1 seconds of arc, is sometimes difficult even with a 10 inch scope. Actually a triple, Zeta's third component lies at a separation of six seconds of arc.

This month's Table of Objects is not large, but it contains a rich and varied assortment of telescopic targets in a constellation that at first looks dull and uninteresting. The faint, fuzzy haze of the Praesepe gave but a small, subtle hint of what lay hidden beyond our sight. First impressions can, indeed, often be misleading!

PUBLISHER'S MEMO

This issue of ASTRONOMY marks the beginning of our second six months of publication. During this short period we increased from 48 to 64 pages and made a tremendous leap in quality. Your enthusiastic response to ASTRONOMY is easily seen in our circulation growth (now more than 16,000 people across the country subscribe to ASTRONOMY).

In keeping with our desire to give you the highest quality magazine possible, we have hired Terence Dickinson as Executive Editor. From the beginning, Mr. Dickinson has written articles for ASTRONOMY on a free-lance basis — but now he will be on our full time staff here in Milwaukee. Previously, he was assistant director of the Strasenburgh Planetarium in Rochester, N.Y.

At the time this memo is being written (Dec. 26, 1973), we have begun our second massive direct mail subscription solicitation campaign. If response to this mailing warrants it, ASTRONOMY magazine will soon increase its size to 80 pages. Watch for the official announcement in a future Publisher's Memo.

You'll notice that Gazer's Gazette is missing this month. For the past several months, we have received many photographs, drawings and observation reports from our readers. The quality of this work is outstanding, and so Sky Almanac has been enlarged this time to include some of the excellent items sent to us. Gazer's Gazette returns next month with a major feature on observing the asteroid Vesta.

Remember, next month we will announce the winner of our "Letters to the Editor" naming contest.

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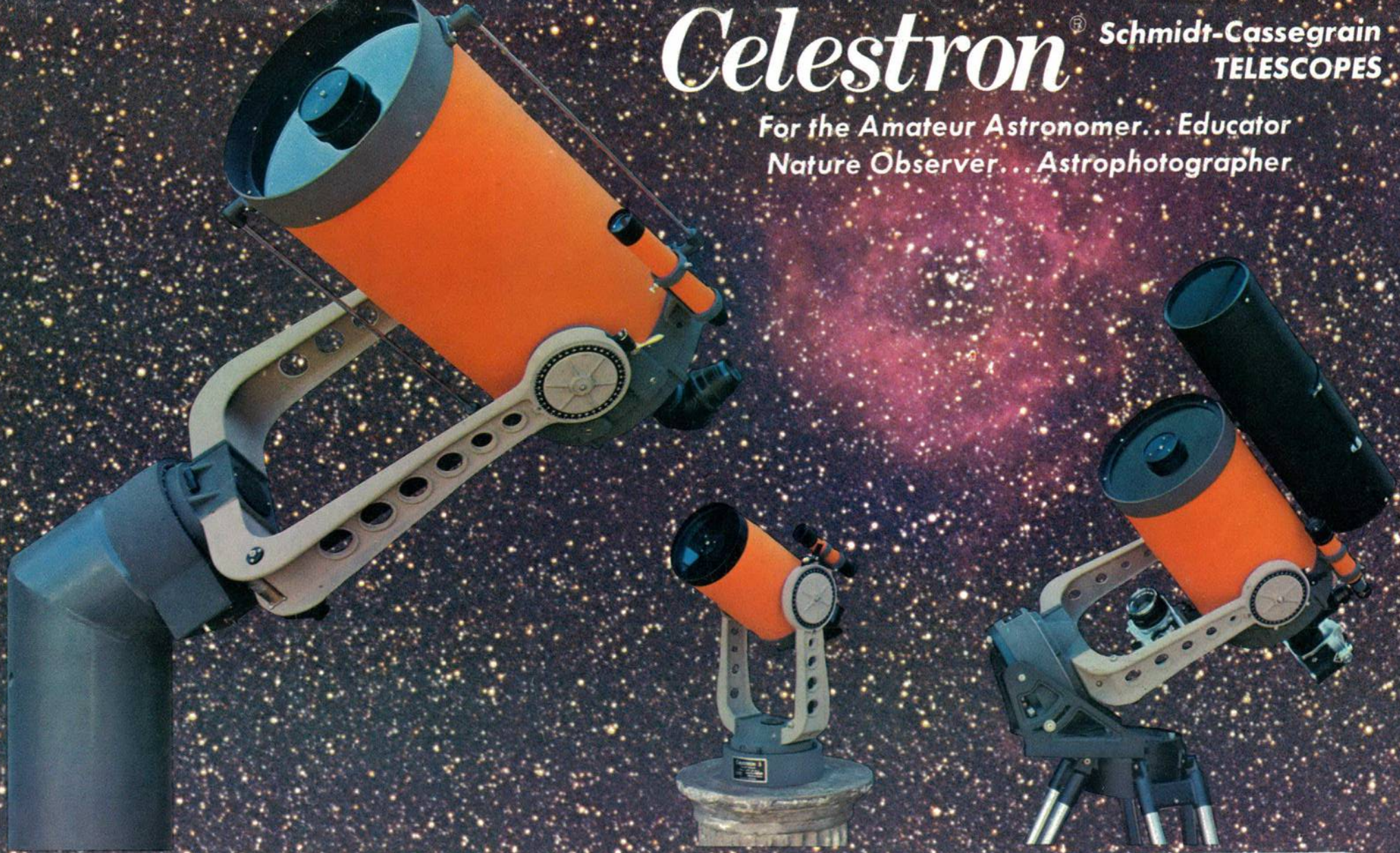

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Background Photo — The Rosette Nebula, Celestron 5½-in. Schmidt Camera

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